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NORTH AMERICAN SPIDERS OF THE GENUS *CTENIUM*

By B. J. KASTON¹

The genus *Ctenium* is represented in North America by 15 known species, of which six are here described as new, with the male of *eremophilus* Chamberlin described for the first time. One species, *livida* Blackwall, is also known from the Palearctic realm.

The type specimens of *floridensis*, *banksi*, and *longipalpus* are deposited in the American Museum of Natural History; of *borealis* and *crosbyi* in the collection of Cornell University; and of *similis* in the Museum of Comparative Zoology. For the privilege of studying these specimens and much other material in their care thanks are due Dr. W. J. Gertsch, Dr. H. Dietrich, and Miss E. B. Bryant of those institutions, respectively. I wish to thank Mr. Wilton Ivie of the University of Utah, Dr. T. B. Kurata of the Royal Ontario Museum, Dr. A. M. Chickering of Albion College, Dr. W. M. Barrows of the Ohio State University, and Dr. E. A. Chapin of the United States National Museum for the loan of other specimens for study. The illustrations were all prepared by my wife.

CTENIUM MENGE

Ctenium MENGE, 1871, Proussische Spinnen (Schrift. Naturf. Gesellsch. Danzig, vol. 2), p. 292. GENOTYPE: *Erigone pinguis* Westring (= *livida* Blackwall).

Robertus O. P.-CAMBRIDGE, 1879, Spiders of Dorset, p. 103. GENOTYPE: *R. astutus* O. P.-Cambridge (= *neglectus* O. P.-Cambridge).

Pedanostethus SIMON,² 1884, Arachnides de France, vol. 5, p. 195. GENOTYPE: *Neriene livida* Blackwall.

Garritus CHAMBERLIN AND IVIE, 1933, Bull. Univ. Utah, vol. 23, no. 4, biol. ser., vol. 2, no. 2,

p. 9. GENOTYPE: *G. vigerens* Chamberlin and Ivie.

Theridiid spiders of the subfamily Asagenaie, of small or moderate size; ranging from 1.69 mm. in the males of *eremophilus* to 4.5 mm. in the females of *vigerens*. Carapace oval, longer than broad, widest at coxae II, not much narrowed at the clypeus, and moderately flat, being highest midway between eyes and thoracic furrow, which is a shallow oval pit. Cephalic groove and radial furrows not strongly marked. Pars cephalica higher and narrower in females than males. Anterior row of eyes straight or very slightly recurved; posterior row virtually straight and slightly longer than the anterior. Anterior median eyes smallest, regularly circular, slightly darker than the others which are pearly white, often irregular in shape, and subequal in size or with the anterior laterals slightly the largest. Eyes in both rows subequidistant, the median ocular area wider behind than in front (sometimes only very slightly so) and wider than long. Lateral eyes contiguous on low tubercles. Height of clypeus varying from just a little less than the length of median ocular area to just a little more than this length.

Chelicerae robust, much longer than the height of the clypeus, vertical, a little geniculate at base (only slightly so in some species, but very much so in *vigerens*) and with distal truncature almost transverse. Fang furrow with three teeth on the promargin (in some cases apparently only two), and with two minute denticles on the retromargin. Of the promarginal teeth the ectalmost may be situated rather far removed from the other two, either quite close to the base of the fang or up on the front of the paturon (as in *vigerens*). The middle tooth is generally the largest of the three

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² Simon proposed *Pedanostethus* to replace Menge's name *Ctenium* which he considered preoccupied in Lepidoptera. But Lefebvre in 1825 had used not *Ctenium* but *Ctenia*, so that according to Article 36 of the Rules of Zoological Nomenclature the former is not invalid.

and the ental tooth smallest. This latter may appear reduced to a cusp at the base of the middle tooth, or may be absent entirely. The dentition in males is similar to that in females, but the chelicerae are not quite so robust. In some species the apical portion just above the fang is compressed or constricted. Fangs stout, with tips overlapping. Labium wider than long, subtriangular, rounded apically, or slightly emarginate; extending to about half the length of the endites. Endites long, widened distally, with outer surfaces more or less straight and inner surfaces slightly inclined around the front of the labium. Endites provided with several setiferous granules, which are larger laterally (and greatly enlarged in *vigerens*).

Sternum subtriangular, almost as wide as long, truncate in front, widest between coxae I and II, ending behind in a blunt, rounded point slightly separating coxae IV. Legs rather robust, relative lengths 1423, or 4123, covered with fine long hairs but completely devoid of spines. With the usual three claws on each tarsus and a comb of serrated bristles under tarsus IV. All legs with tarsus shorter than metatarsus. Tibiae with several trichobothria; metatarsi with one or two. Palp of female with a denticulate claw.

Abdomen oval, moderately flattened, widest about the middle, and with one-fifth to one-fourth its length overlapping the cephalothorax. Spinnerets subterminal, not visible from above, the anterior pair slightly thicker and longer than the posterior. Colulus very large and conspicuous.

Males are provided with a stridulating apparatus consisting of an *area stridulans*, or "file" of several transverse striae on the posterior portion of the carapace, and a "pick" of eight or 10 strong setae arising from a lunate plate above the pedicel on the front of the abdomen.

In general appearance the species resemble one another closely. The carapace is yellowish brown to chestnut or reddish brown, with occasional melanistic specimens showing irregular gray blotches here and there. Except for a few bristles near the thoracic furrow and around the eyes the carapace is glabrous. The legs are brown

or orange, somewhat lighter on the femora than on the more distal segments. The abdomen is usually gray, but varies from a grayish tan to black, and is covered with a sparse even pubescence. The four dorsal muscle impressions are conspicuous, and in addition there is usually an irregular scattering of light spots over the dorsum. The venter is gray.

Species differentiation is based almost entirely upon genitalia characteristics. In the male the pedipalp is long, with the femur longer than the patella and tibia together. The tibia is always longer than the patella, is narrow at the base but widened distally where it is produced on the ectal side to form a flat lobe with rounded edge covering the base of the palpal organ. Close to the edge of this tibial lobe arises a row of seven to 10 long hairs which extend distally one-half to three-fourths the length of the palpal organ. In figure 7 these are shown as they appear from the side, but for the sake of clarity they are omitted from the other drawings of the palpi, only the basal articulating sockets being drawn in. Along the ectal border of the cymbium is a notch or cleft between the cymbium proper and a narrow triangular lamella. This lamella, characteristic of the genus, is drawn out to a point and turned toward the palpal organ. The lamella usually arises rather near the distal end of the cymbium, but in some species from farther proximad. Its relative size, point of origin, amount of space between it and the cymbium proper, the width of the cymbium compared with the length, and the length of the latter as compared with the length of the tibia and patella together are all good characters useful for species differentiation. In making comparisons of length the greatest length of the tibia, including the lobe, is used.

The palpal organ itself presents a heavily sclerotized median apophysis lying on the prolatero-ventral side. Its shape and size are characteristic for each species, and in the drawings supplied of the lateral aspect of the palpi this structure is shaded while the other parts are left in outline. There is usually a sclerotized terminal apophysis variously developed, and associated with it a transparent membranous process which

extends toward and usually overlies at least part of the cymbial lamella.

In females the epigyna do not all conform to one general type. In most species there is an anterior median lobe attached in front and free behind. The openings lie on either side of the "stem" attaching the lobe in front, but are usually quite difficult to see. In some species there is a flap-like posterior lobe as well, usually provided with a heavily sclerotized lip.

Ctenium may be distinguished from the related genus *Enoplognatha* in having the labium longer, the endites more inclined over the labium in front, the carapace relatively higher, the legs stouter, the sternum not so prolonged between the posterior coxae, and the chelicerae more robust and not exhibiting so much sexual dimorphism.

Very little is known of the habits of these spiders other than that they live in moss, and under stones or boards on the ground. They have been found mature at all seasons and are usually collected by sifting forest floor litter. Wiehle (1937, "Theridiidae," in "Spinnentiere Deutschlands") reports having witnessed the mating of *livida* in April. A mating web had been spun high up among grass stems. Blackwall (1864, "Spiders of Great Britain and Ireland," p. 252), for the same species, describes the cocooning as follows: "The female in July spins several globular cocoons of white silk of a slight texture, attaching them to some depression in the stone selected for her retreat; the largest of these cocoons measures 1/7th inch in diameter and comprises about 30 spherical eggs of a pale yellowish-white color, not agglutinate together."

The species most commonly represented in study collections is *riparius*, and because of the great superficial resemblance to it of *banksi*, *laticeps*, and *longipalpus* most specimens of these less well-known species had been mistakenly identified as *riparius* in these collections.

KEY TO SPECIES OF *Ctenium*

1. Chelicerae very heavy and powerful (figs. 9 and 10), with a prominent large tooth above the base of the fang. Epigynum (fig. 55) with a transverse lip, in front of which are

the receptacles and behind which is a narrow fossa. Cymbium much shorter than patella plus tibia and with four distal stout setae (fig. 31)

..... *vigerens*
Chelicerae not so powerful; with ectal tooth smaller than the middle one and closer to the promargin of the fang furrow. Cymbium longer than patella plus tibia (or hardly shorter) and with two or three distal stout setae, or none. Epigynum not as above..... 2

2. Females..... 3
Males¹..... 16

3. Epigynum as long as, or longer than, the venter between it and the spinnerets, and with an unpigmented backwardly directed process (fig. 57)..... *spiniferus*

Epigynum much shorter and without a backwardly directed process... 4

4. Epigynum with a more or less conspicuous anterior median lobe... 6
Epigynum without a conspicuous anterior median lobe..... 5

5. Epigynum with a posterior pigmented plate on which converge a pair of tubules from the anteriorly placed receptacles (fig. 58)..... *livida*

Epigynum with a large anterior median fossa and a pair of lateral prominences (fig. 56)..... *fusca*

6. Epigynum with a more or less well-developed, flap-like posterior lip... 8
Epigynum without such a posterior lip..... 7

7. Epigynum with the receptacles at the anterior border. Median lobe quite small (fig. 54)..... *eremophilus*

Epigynum with the receptacles farther back from the anterior end. Median lobe quite large and almost circular (fig. 52)..... *croasbyi*

8. Median lobe attached in front by a narrow "stem"..... 11
Median lobe broadly attached..... 9

9. Median lobe much longer than wide (fig. 49)..... *banksi*
Median lobe wider than long..... 10

10. Posterior lip of epigynum heavily

¹ Males of *croasbyi*, *floridensis*, and *similis* are unknown.

- sclerotized as a transparent flap projecting slightly beyond epigastric furrow (fig. 53)..... *pumilus*
 Posterior lip a much larger flap, but not so heavily sclerotized and not projecting beyond epigastric furrow (fig. 51)..... *frontata*
11. Median lobe large, as long as that part of the epigynum posterior to it, or almost so.....12
 Median lobe much smaller than above.....13
12. Posterior lip evenly procurved (fig. 47)..... *longipalpus*
 Posterior lip undulating (fig. 48)..... *floridensis*
13. Epigynum with a large flap projecting backward two-fifths the length of the entire epigynum (fig. 50). Median lobe at least as wide as long. Receptacles small and close to the anterior edge..... *borealis*
 Flap of epigynum projecting backward only a small amount. Median lobe including "stem" longer than wide. Receptacles as large as median lobe and some distance from anterior edge of epigynum.....14
14. Median lobe of epigynum almost circular to broadly oval in shape, with a distinct long "stem." Receptacles about as large as median lobe. Epigynum with a posterior heavily sclerotized lip which is either evenly procurved (as in fig. 46) or somewhat undulate..... *laticeps*
 Median lobe pear-shaped or slightly angular. Receptacles larger than the median lobe.....15
15. Median lobe almost as wide as long. Receptacles far forward (fig. 44)..... *riparius*
 Median lobe much longer than wide. Receptacles farther back and entire epigynum (fig. 45) wider than in *riparius*..... *similis*
16. Cymbium of palp with two or three stout setae at or near apex.....17
 Cymbium devoid of stout apical setae.....21
17. Cymbium with an attenuated slender distal extension and with the stout setae arising some distance from its tip. A wide space between lamella and cymbium proper (fig. 36). Terminal apophysis slender (fig. 35)..... *frontata*
 Cymbium not attenuated. Stout setae at apex. Space between lamella and cymbium proper very narrow.....18
18. Cymbium with three stout apical setae. Median apophysis of moderate size with proximal ramus very short..... *banksi*
 Cymbium with only two stout setae. Median apophysis larger.....19
19. Terminal apophysis not much wider at base than distally, where it ends in three short blunt lobes (fig. 14). Median apophysis with a transverse proximal ramus..... *laticeps*
 Terminal apophysis much wider at base than distally where it is drawn out as two fine points. Median apophysis with proximal ramus more longitudinal.....20
20. Cymbium relatively long and narrow (fig. 21), the patella and tibia together only seven-eighths its length. Median apophysis with well-developed long proximal ramus. Terminal apophysis gently curved distally (fig. 20)..... *longipalpus*
 Cymbium shorter and wider (fig. 13), no longer than the patella and tibia together. Median apophysis with much shorter proximal ramus. Terminal apophysis abruptly bent distally (fig. 11)..... *riparius*
21. Median apophysis very large, with a long thin proximal ramus that extends abruptly ventrad for some distance (fig. 24)..... *spiniferus*
 Median apophysis with a much shorter proximal ramus.....22
22. Tibia and patella together slightly (25/22) longer than cymbium. (Proximal ramus of median apophysis a narrow curved hook, fig. 27)..... *eremophilus*
 Cymbium not shorter than tibia plus patella.....23
23. Median apophysis without a proximal ramus. Terminal apophysis very short. Palpal organ without a dis-

- tal membranous process (fig. 17).
 *livida*
 Median apophysis with a proximal
 ramus. A distal membranous process
 present near lamella. 24
24. Terminal apophysis represented by a
 broad transparent lobe extending
 across apex of bulb (fig. 38). Tibia
 and patella together the same
 length as cymbium. *fusca*
 Terminal apophysis a stout process.
 Tibia and patella together not quite
 so long as cymbium. 25
25. Median apophysis with the proximal
 ramus simple (fig. 33). Terminal
 apophysis evenly curved distally
 (fig. 32). *pumilus*
 Median apophysis large and with the
 proximal ramus itself subdivided
 (fig. 42). Terminal apophysis
 abruptly bent at apex (fig. 41).
 *borealis*

Ctenium banksi, new species

Figures 1-8, 49

Pedanoctethus riparius EMERTON, 1909, Trans. Connecticut Acad. Sci., vol. 14, p. 182 (in part), pl. 1, fig. 1d, ♀ (not ♂); COMSTOCK, 1912, Spider book, p. 365 (in part), fig. 372b, ♀ (not *riparius* Keyserling).

Pedanoctethus palustris BANKS, 1916, Proc. Acad. Nat. Sci. Philadelphia, p. 77 (in part), pl. 11, fig. 25, ♀ (not ♂).

Robertus palustris CROSBY AND BISHOP, 1928, Cornell Univ. Agr. Exp. Sta. Mem., no. 101, p. 1040 (in part, not ♀).

Robertus riparius COMSTOCK, 1940, Spider book, rev. ed., p. 380 (in part), fig. 372b, ♀.

sions conspicuous, with a sprinkling of very small white spots irregularly arranged, and covered with a sparse pubescence.

Carapace widest at coxae II, highest between the eyes and the thoracic groove, which is a shallow oval pit. Cephalic groove and radial furrows only faintly indicated. Anterior eye row with medians smaller than laterals, a diameter apart and about the same distance from the laterals. Posterior row longer than anterior (34/30), the eyes subequal and subequidistant, about a diameter apart. Lateral eyes of both rows contiguous. Median ocular area wider behind than in front, about as long as wide. Clypeus almost vertical, its height slightly greater than the length of the median ocular area.

Chelicerae vertical, slightly geniculate, almost three times as high as the clypeus. Near the distal end just above the fang the chelicerae are compressed a little so as to form a slight keel. Promargin of fang furrow with three teeth, of which the middle one is largest; retromargin with two minute denticles. Labium much wider than long (18/12). Endites swollen distally, a little inclined over labium which is about half their length, and is provided with a few setiferous granules. Sternum almost as wide as long (52/60), widest between coxae I and II, subtriangular, ending behind in a short rounded point separating coxae IV by about one-third their length.

Legs 1423, devoid of spines, but covered with long fine hairs.

LEG	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	1.27	1.60	.90	.61	4.38 mm.
II	1.04	1.27	.73	.55	3.59 mm.
III	.87	1.01	.61	.52	3.01 mm.
IV	1.30	1.45	.84	.61	4.20 mm.

MALE: Total length, 3 mm. Carapace, 1.57 mm. long, 1.16 mm. wide. Abdomen, 1.67 mm. long, 1.34 mm. wide.

Carapace glabrous, orange, somewhat darker on the head and with eyes ringed with black. Chelicerae, maxillae, and sternum slightly darker than carapace. Legs yellow to orange, lightest on femora, darkest distally. Abdomen gray above and below, with the four dorsal muscle impres-

Tibial index of leg I = 10.8; of leg IV = 12.9.

Abdomen with its anterior fifth overhanging the cephalothorax. Spinnerets subterminal, not visible from above, the anteriors longest and thickest. Colulus large and conspicuous.

Pedipalp with patella and tibia together about two-thirds the length of femur and seven-eighths as long as cymbium. Along

the distal edge of the tibial lobe is a row of long hairs, and the cymbium is provided with three stout apical setae. Palpal organ with the terminal apophysis subtriangular, broad basally, ending in two fine points turned toward the transparent membranous process. Median apophysis of moderate size, with a proximal short thick spur.

FEMALE: Total length, 3.5 mm. Carapace, 1.6 mm. long, 1.24 mm. wide. Abdomen, 2.09 mm. long, 1.54 mm. wide.

Similar to male in general appearance and structure. However, the cephalic furrow is more marked, the head is higher, and the chelicerae are stouter, more geniculate and not compressed distally. Legs somewhat stouter with tibial index of leg I = 12.1; of leg IV = 13.2.

Epigynum with a U-shaped anterior median lobe, with minute openings on either side of its anterior attachment. A pair of receptacles, each a little larger than the median lobe, lie to the sides and behind it. Posterior border of epigynum developed into a thick, sclerotized, procurved lip.

TYPE LOCALITY: Male holotype from Ottawa, Ontario, June 21, 1939. Female allotype from Rowayton, Connecticut, April 14, 1945, collected by C. J. Goodnight.

DISTRIBUTION: **ONTARIO:** Arnprior, September, 1934 (Macnamara). **NEW HAMPSHIRE:** Fitzwilliam, May 24-30, 1907 (E. B. Bryant). **VERMONT:** Jamaica, July 11, 1913 (R. V. Chamberlin). **MASSACHUSETTS:** Monponsett, June 12, 1912 (J. H. Emerton); Topsfield, May 16, 1914 (J. H. Emerton); Blue Hills, November 5, 1914 (J. H. Emerton); Clarendon Hills, November 10, 1904, and September 27, 1905 (J. H. Emerton); Brookline, November 22, 1904 (J. H. Emerton). **NEW YORK:** Ithaca, May 22 (N. Banks); Peru, October 22, 1934; McLean, May 30, 1910, and May 30, 1921; May 29, 1926 (R. V. Chamberlin); Owasco Lake; Flushing, November 15, 1918; Howland's Island, November 14, 1916; Nigger Pond, Oswego County, September 3, 1926; North Pond, Oswego County, July 27, 1935 (C. R. Crosby); Maratanza Lake, May 24, 1920; Raquette Lake, June 11, 1927; Cayuta Lake, September 2, 1935 (C. R. Crosby); Suffern, May 26, 1924; Old Forge. **NEW JERSEY:** Lakehurst, May 1, 1912 (J. H. Emerton). **MARYLAND:** Branchville, October 22, 1941, and March 12, 1942 (M. H. Muma). **MICHIGAN:** Winnipeg Lake, October 15, 1932 (A. M. Chickering). **WISCONSIN:** St. Croix Falls, February 20, 1899; Kimball, July 2, 1910 (R. V. Chamberlin).

SPECIMENS EXAMINED: Males: 12, with lengths ranging from 2.81 to 3.3 mm. Females: 45, ranging from 3.02 to 4.15 mm. This species is very similar to *laticeps*, *riparius*, and *longipalpus*, though the latter is somewhat smaller. Judging by the structure of the epigynum, *floridensis*, *similis*, and *crosbyi* (of which the males are unknown) also appear to belong to this group.

Ctenium borealis, new species

Figures 41-43, 50

MALE: Total length, 2.4 mm. Structure and general appearance typical as described for *banksi*, new species, but the chelicerae are not compressed near the fang. Pedipalp with patella and tibia together over three-fifths the length of femur and almost as long (33/36) as the cymbium. The latter is quite wide and not provided with any stout distal setae. The median apophysis is enormously enlarged and developed into a pointed distal ramus, and a proximal ramus which is itself subdivided, as shown in figure 42. The terminal apophysis is stout and ends in a sharply bent thick hook which lies over a transparent membranous process.

FEMALE: Total length, 2.94 mm. Structure and general appearance as in male. The epigynum has a very wide anterior median lobe and small receptacles close to the anterior edge. The most characteristic feature of the epigynum is the fact that the posterior two-fifths is developed as a thick flap projecting from the surface of the abdomen proper.

TYPE LOCALITY: Male holotype and female allotype from Arnprior, Ontario, May 1935 (Macnamara). Male and female paratypes were taken with the holotype and allotype.

DISTRIBUTION: **MAINE:** Presque Isle, August 26, 1925. **NEW YORK:** Michigan Mills, September 1, 1926; Moores, September 26, 1936 (C. R. Crosby); West Kilns, June 28, 1931; Saranac Lake, September 6, 1931 (C. R. Crosby). **MICHIGAN:** Marquette, July 27, 1932 (A. M. Chickering).

SPECIMENS EXAMINED: Males: 4, with lengths ranging from 2.15 to 2.4 mm. Females: 9, ranging from 2.5 to 3.15 mm. In some females the median lobe of the epi-

gynum is more nearly circular than is shown in figure 50.

Ctenium crosbyi, new species

Figure 52

FEMALE: Total length, 3.3 mm. Structure and general appearance typical as described for *banksi*, new species, but with the chelicerae somewhat less robust and less geniculate. The epigynum is of the same general type as in *banksi*, *laticeps*, *riparius*, etc., but the median lobe is relatively larger and almost circular. On either side of the lobe are what appear to be quite small receptacles, and a posterior lip is not well developed.

TYPE LOCALITY: Female holotype from Raquette Lake, New York, June 11, 1927. One female paratype from Ampersand Brook, Franklin County, New York, July 19, 1931 (Crosby and Hammer). This latter specimen is only 2.7 mm. long.

Ctenium eremophilus (Chamberlin)

Figures 26-28, 54

Robertus eremophilus CHAMBERLIN, in Chamberlin and Gertsch, 1928, Proc. Biol. Soc. Washington, vol. 41, p. 180, ♀.

MALE: For the seven specimens examined, the total length ranged from 1.68 to 2.15 mm. Structure and general appearance typical as described for *banksi*, new species, except that the chelicerae are weaker than usual for the genus, not compressed near the fang, and the promargin of the fang furrow is provided apparently with only two teeth, the small one nearest the tip of the fang having disappeared. As in *frontata* the anterior surface of the chelicerae is covered with numerous fine rugosities. Pedipalp with patella and tibia together five-sixths as long as the femur and slightly longer (25/22) than the cymbium. The latter is about half as wide as long and is without any stout setae at the apex. The median apophysis is of moderate size with a hooked proximal ramus. The terminal apophysis is somewhat as in *borealis*, but is more slender and less abruptly curved at the apex.

FEMALE: The type specimen is a gravid individual 3.5 mm. long, but 11 other specimens ranged from 1.9 to 2.42 mm. in

length. Structure and general appearance typical, and as in the male there are but two promarginal teeth on the chelicerae. The epigynum has a very short median lobe, and a pair of anteriorly placed receptacles.

TYPE LOCALITY: Female holotype (in the collection of the University of Utah) from Devil's Canyon, San Juan County, Utah, April 18, 1928, collected by W. J. Gertsch. A paratype female was taken with the type.

DISTRIBUTION: NEW YORK: Ithaca, July (N. Banks); December (C. R. Crosby); June 22, 1927 (P. Needham); McLean, May 26, 1934 (H. Dietrich); Montauk Point, May 24, 1924. OHIO: Gambier, August, 1907; Rock Creek, May 20, 1945 (J. C. Pallister). ILLINOIS: near Chicago, June; Salts, August 15, 1926 (Smith). MICHIGAN: Albion, December 5, 1932, and May 1933 (A. M. Chickering). UTAH: Verdure, May 10, 1933 (W. Ivie).

Ctenium floridensis, new species

Figure 48

FEMALE: Total length, 3.5 mm. Structure and general appearance typical as described for *banksi*, new species. However, the head is somewhat higher, and as in *vigerens* the endites are somewhat swollen distally. The ectal tooth on the promargin of the cheliceral fang furrow is somewhat removed from the other two, but it is not so enlarged as in *vigerens*. The epigynum has the same general structure as in *longipalpus*, *laticeps*, *riparius*, etc., but the median lobe is relatively much larger than in the latter two species and the shape of the posterior lip easily separates it from the former.

TYPE LOCALITY: Female holotype from Blountstown, Florida, April 17, 1938, collected by W. J. Gertsch.

Ctenium frontata (Banks)

Figures 35-37, 51

Microneta frontata BANKS, 1892, Proc. Acad. Nat. Sci. Philadelphia, p. 48, pl. 5, fig. 51, ♀; BANKS, 1910, Bull. U. S. Natl. Mus., no. 72, p. 35; PETRUNKEVITCH, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 257.

Pedanostethus pumilus BANKS, 1916, Proc. Acad. Nat. Sci. Philadelphia, p. 77 (not *pumilus* Emerton).

Pedanostethus terrestris EMERTON, 1914, Jour. New York Ent. Soc., vol. 22, p. 262, pl. 8, fig.

2-2a, ♂; BARROWS, 1918, Ohio Jour. Sci., vol. 18, p. 304; EMERTON, 1919, Trans. Roy. Canadian Inst., vol. 12, p. 313.

Robertus terrestris CROSBY AND BISHOP, 1928, Cornell Univ. Agr. Exp. Sta. Mem., no. 101, p. 1040.

MALE: For the 23 specimens examined, the total length ranged from 1.74 to 2.48 mm. Structure and general appearance typical as described for *banksi*, new species, but the chelicerae are not compressed near the fang. Moreover, as in *eremophilus*, the chelicerae are not so robust as is usual for the genus, and the anterior surface is dotted with many small rugosities. There are the usual three promarginal teeth. Pedipalp with patella and tibia together about two-thirds as long as the femur and four-fifths as long as the cymbium. The shape of the cymbium is quite characteristic; it is provided with a distal prolongation which is curved, spiral fashion, ventrally and toward the retrolateral side. The lamella is stout and there is a considerable space between it and the cymbium proper. There are two stout setae fairly close to the lamella, much farther from the apex of the cymbium than in any of the other species. These setae are longer than in the other species, and the more distal one is quite a bit stouter than the more proximal. The median apophysis is quite small, with a very short proximal ramus. The terminal apophysis is long and slender with its two distal spurs overlying a very conspicuous membranous process.

FEMALE: For the 47 specimens examined, the total length ranged from 2.14 to 3.08 mm. Structure and general appearance as in the male. The epigynum has a very broad anterior median lobe behind a raised lip, a pair of very conspicuous receptacles converging posteriorly, and a posterior border formed by a thick curved lip raised from the surface of the abdomen proper.

TYPE LOCALITY: Female type of *frontata* collected at Ithaca, New York (N. Banks). Male type of *terrestris* collected at Ithaca, New York, May 18, 1911 (J. H. Emerton). Both types are at the Museum of Comparative Zoölogy.

DISTRIBUTION: CONNECTICUT: New Haven, December 15, 1882 (J. H. Emerton); Kent, Au-

gust 4, 1908 (J. H. Emerton); Norwalk, July 2, 1933 (W. Ivie); Rowayton, July, 1945 (C. J. Goodnight). NEW YORK: Cornwall, May 30, 1913 (J. H. Emerton). NEW JERSEY: Berkeley Heights. PENNSYLVANIA: President, July 3, 1922; Conyngham. MARYLAND: College Park, November 5, 1931 (C. R. Crosby); College Park, December 10, 1941, and February 22, 1942 (M. H. Muma); Berwyn, October 8 and 22, 1944 (M. H. Muma); "D. C. Lako," August 29, 1942 (M. H. Muma). NORTH CAROLINA: Mingus Creek, February 1, 1943 (W. M. Barrows); Newfound Gap, August 31, 1930 (P. J. Darlington). TENNESSEE: Blount County, September, 1931; Erwin, July 8, 1933 (W. Ivie); Little Pigeon Creek, July 9, 1933 (W. Ivie). OHIO: Cantwell Cliffs, Hocking County, May 30, 1932 (C. R. Crosby); Rockbridge, August 13, 1932 (W. M. Barrows). This species has also been listed from Manitoba by Emerton (1919).

Ctenium fusca (Emerton)

Figures 38-40, 56

Steatoda fusca EMERTON, 1894, Trans. Connecticut Acad. Sci., vol. 9, p. 407, pl. 2, fig. 1-1b, ♀ ♂; BANKS, 1910, Bull. U. S. Natl. Mus., no. 72, p. 21; PETRUNKEVITCH, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 188.

Pedanostethus fuscus EMERTON, 1911, Trans. Connecticut Acad. Sci., vol. 16, p. 387, pl. 1, fig. 3, ♀ ♂; EMERTON, 1919, Trans. Roy. Canadian Inst., vol. 12, p. 312.

Robertus fuscus CROSBY AND BISHOP, 1928, Cornell Univ. Agr. Exp. Sta. Mem., no. 101, p. 1040; CHICKERING, 1935, Papers Michigan Acad. Sci., vol. 20, p. 584.

MALE: For the 12 specimens examined, the total length ranged from 2.48 to 2.75 mm. Structure and general appearance typical as described for *banksi*, new species, but the chelicerae are not compressed near the fang. Pedipalp with patella and tibia together two-thirds as long as the femur and as long as the cymbium. The latter is devoid of stout apical setae, and is fairly wide. It is not quite so wide as in *borealis* and *pumilus*, and the space between the lamella and cymbium proper is less than in *pumilus* but more than in *borealis*. The median apophysis is strongly developed with the distal ramus smoothly rounded apically, and the proximal ramus produced and lying transversely across the bulb. The terminal apophysis is a flat semi-transparent structure whose tip overlies a whitish membranous process near the lamella.

FEMALE: For the 38 specimens examined, the total length ranged from 2.48 to

3.75 mm. Structure and general appearance typical as in the male. The epigynum is quite different from any of the other species in the genus. There is a large central fossa in the anterior half, and on either side is a raised area, the two latter connected behind by a transverse ridge.

TYPE LOCALITY: Male and female co-types from Laggan, Alberta, collected by Thomas E. Bean and now at the Museum of Comparative Zoölogy.

DISTRIBUTION: LABRADOR: Paradise River, July 16, 1928 (C. L. Austing). MAINE: Fort Fairfield, July 19, 1914 (J. H. Emerton); Presque Isle, August 26, 1925; Lubec, July 30, 1913 (J. H. Emerton). NEW HAMPSHIRE: Mt. Washington, June 10, 1877, and August 1, 1910 (J. H. Emerton); August 18, 1925; Cater Notch, August 10, 1906 (J. H. Emerton). VERMONT: Grout, July, 1913 (R. V. Chamberlin); Ascutney, May 25, 1913 (J. H. Emerton). CONNECTICUT: Rainbow, August 9, 1939 (A. DeCaprio). ONTARIO: Menaki, July 30, 1917 (J. H. Emerton). NEW YORK: Mt. Marcy, July 1918 (J. H. Emerton), August 27, 1930 (C. R. Crosby); Mt. Whiteface, August 22, 1916; Mt. McIntyre, July 24, 1925; Highfalls, Essex County, August 30, 1921; Wawbeek, October 23, 1934; Avalanche Lake, July 24, 1925. MICHIGAN: Marquette, July 23, 1932 (A. M. Chickering). MINNESOTA: Itasca Park, May 28-30, 1932 (W. J. Geitsch). WYOMING: Yellowstone Park, August 14, 1927 (R. V. Chamberlin), August 11, 1940 (W. Ivie).

Ctenium laticeps (Keyserling)

Figures 14-16, 46

Theridion laticeps KEYSERLING, 1884, Spinnen Amerikas, Theridiidae, vol. 1, p. 96, pl. 5, fig. 63-63b, ♀; MARX, 1890, Proc. U. S. Natl. Mus., vol. 12, p. 519.

Pedanostethus laticeps BANKS, 1910, Bull. U. S. Natl. Mus., no. 72, p. 22; PETRUNKEVITCH, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 184; WORLEY AND PICKWELL, 1931, Univ. Nebraska Studies, vol. 27, p. 28; FOX, 1940, Proc. Biol. Soc. Washington, vol. 53, p. 41.

Microneta palustris BANKS, 1892, Proc. Acad. Nat. Sci. Philadelphia, p. 47, pl. 2, fig. 47, ♂.

Pedanostethus palustris BANKS, 1910, Bull. U. S. Natl. Mus., no. 72, p. 22; PETRUNKEVITCH, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 185; BANKS, 1916, Proc. Acad. Nat. Sci. Philadelphia, p. 77, pl. 11, fig. 16, ♂ (not ♀, fig. 25).

Robertus palustris CROSBY AND BISHOP, 1928, Cornell Univ. Agr. Exp. Sta. Mem., no. 101, p. 1040 (in part).

Pedanostethus riparius BANKS, 1907, Indiana Dept. Geol. Nat. Hist. Res., 31st Ann. Rept., p. 739 (not *riparius* Keyserling).

MALE: For the 18 specimens examined, the total length ranged from 2.89 to 3.35

mm. Structure and general appearance typical as described for *banksi*, new species, with the chelicerae compressed near the fang. Pedipalp with patella and tibia together three-fifths as long as femur and seven-eighths the length of cymbium. The cymbium is quite elongate and has two stout apical setae. The median apophysis has a rather short distal ramus and a very broad proximal ramus that extends transversely beyond the border of the cymbium. The terminal apophysis is gently curved and ends in three short blunt lobes which overlie the distal transparent membranous process.

FEMALE: For the 42 specimens examined, the total length varied from 3.09 to 4.15 mm. Structure and general appearance as in male. Epigynum of the same general type as in *riparius* and *similis*, but with the anterior median lobe a broad oval (to almost spherical) and with a relatively long stem. The sclerotized lip along the posterior border is undulate in some specimens and evenly curved in others.

TYPE LOCALITY: Female type of *laticeps* from Fort Bridger, Wyoming, now in the United States National Museum. Male type of *palustris* collected at Ithaca, New York, by N. Banks, now in the Museum of Comparative Zoölogy.

DISTRIBUTION: CONNECTICUT: South Meriden, March 31, 1935 (H. L. Johnson). NEW YORK: Ithaca, May 22 and 23 (N. Banks), December 29, 1912; Montauk Point, June 25, 1927, and July 30, 1933 (C. R. Crosby). PENNSYLVANIA: Shillington, August 6, 1936 (L. Hook). MARYLAND: College Park, April 22, 1942 (M. H. Muma). VIRGINIA: Falls Church (N. Banks); Chain Bridge, May 23; Radford, July 6, 1934. NORTH CAROLINA: Roan Mountain, July 5, 1903 (J. H. Emerton), July 13 (N. Banks); Black Mountain (N. Banks). TENNESSEE: Klingman's Dome, June 25, 1936 (W. M. Barrows); Erwin, July 8, 1933 (W. Ivie). OHIO: Salineville; Columbus, September 22, 1917 (W. M. Barrows). INDIANA: Knox County, May 26. ILLINOIS: Peoria, July 9. IOWA: Ames. NEBRASKA: near Falls City, June 7, 1933 (W. Ivie).

Ctenium livida (Blackwall)

Figures 17-19, 58

Nerine livida BLACKWALL, 1836, London and Edinburgh Phil. Mag., vol. 8, p. 468, ♀ ♂.¹

¹ Although the descriptions and figures supplied here are based upon European specimens, I have included (except for the citation to the original description) only those references pertaining to North American records.

Pedanostethus lividus KEYSERLING, 1886, *Spinnen Amerikas, Theridiidae*, vol. 2, p. 126, pl. 15, fig. 206-206a, ♀; MARX, 1890, *Proc. U. S. Natl. Mus.*, vol. 12, p. 531; SIMON, 1894, *Histoire naturelle araignées*, vol. 1, p. 579; PETRUNKEVITCH, 1911, *Bull. Amer. Mus. Nat. Hist.*, vol. 29, p. 184.

MALE: For the six specimens examined, the total length ranged from 2.55 to 3.2 mm. Structure and general appearance typical as described for *banksi*, new species, with the chelicerae compressed distally as in that species. Pedipalp with the patella and tibia together slightly over half as long as the femur and three-fourths as long as the cymbium. The latter is devoid of stout distal setae and has the lamella drawn out to a very long fine point lying in a concavity of the cymbium proper. The median apophysis is of moderate size, rounded apically, broadened at its base, and lacking a proximal ramus. The terminal apophysis is short, and a distal membranous process seems to be lacking.

FEMALE: For the eight specimens examined, the total length ranged from 2.9 to 3.8 mm. Structure and general appearance as in male. The epigynum has a pair of anteriorly placed receptacles from which extend tubules converging to meet behind at the center of a darkly pigmented, shallowly concave plate (fig. 58).

TYPE LOCALITY: Llanrwst, Wales.

DISTRIBUTION: ALASKA: Ft. Yukon (Marx Collection at the United States National Museum). Reported also from Sitka by Keyserling (1886). (Widely distributed throughout the Palearctic region.)

Ctenium longipalpus, new species

Figures 20-22, 47

MALE: Total length, 2.35 mm. Structure and general appearance typical as described for *banksi*, new species, with the chelicerae compressed near fang. Pedipalp with patella and tibia together three-fourths as long as femur and seven-eighths as long as the cymbium. The latter is long and narrow, and provided with two stout distal setae. The median apophysis is well developed with the proximal ramus long and twisted slightly to extend out beyond the border of the cymbium. The terminal apophysis is subtriangular, with a very broad base and with its distal end drawn

out to two fine points overlying a large membranous process.

FEMALE: Total length, 2.8 mm. Structure and general appearance similar to male. Epigynum with a very large, broadly attached, spoon-shaped anterior median lobe. At the posterior border of the epigynum there is a thick raised lip which makes this species easy to distinguish from *floridensis*, in which the anterior median lobe is also quite large.

TYPE LOCALITY: Male holotype from Ramsey, New Jersey, June 3, 1934, collected by W. J. Gertsch. Female allotype from the same locality, December 1, 1912, collected by J. H. Emerton. A paratype female was collected with the allotype.

DISTRIBUTION: NEW HAMPSHIRE: Gilman-town, June 12-18, 1925 (E. B. Bryant). MASSACHUSETTS: Monponsett, June 12, 1913 (J. H. Emerton); Holliston, June 10, 1923 (J. H. Emerton and N. Banks); Clarendon Hills, September 27, 1905. CONNECTICUT: Norwalk, May 27-30, 1933 (W. J. Gertsch) and July 2, 1933 (W. Ivie); Killingworth, January, 1938 (B. J. Kaston). ONTARIO: Mer Bleu near Ottawa, July 10, 1941 (H. H. T. Nesbit). NEW YORK: McLean, May 29, 1926 (R. V. Chamberlin); Nigger Pond, Oswego County, September 3, 1926. NEW JERSEY: Ramsey. MICHIGAN: Albion, October 8, 1932 (A. M. Chickering).

SPECIMENS EXAMINED: Males: 10, with the total length ranging from 2.35 to 2.61 mm. Females: 9, ranging from 2.2 to 3.15 mm. This species is quite similar to *laticeps*, *riparius*, and *banksi*, but is smaller in size.

Ctenium pumilus (Emerton)

Figures 32-34, 53

Pedanostethus pumilus EMERTON, 1909, *Trans. Connecticut Acad. Sci.*, vol. 14, p. 183, pl. 1, fig. 2-2a, ♀ ♂; EMERTON, 1911, *ibid.*, vol. 16, pl. 1, fig. 3a, ♂; BANKS, 1910, *Bull. U. S. Natl. Mus.*, no. 72, p. 22; PETRUNKEVITCH, 1911, *Bull. Amer. Mus. Nat. Hist.*, vol. 29, p. 185; EMERTON, 1913, *Appalachia*, vol. 12, p. 155; ELLIOTT, 1930, *Ohio Jour. Sci.*, vol. 30, p. 5; ELLIOTT, 1932, *Proc. Indiana Acad. Sci.*, vol. 41, p. 424.

Robertus pumilus CROSBY AND BISHOP, 1928, *Cornell Univ. Agr. Exp. Sta. Mem.*, no. 101, p. 1040.

MALE: For the 15 specimens examined, the total length ranged from 1.74 to 2.14 mm. Structure and general appearance typical as described for *banksi*, new species, with the chelicerae compressed distally as in that species. Pedipalp with patella and

tibia together seven-tenths the length of the femur and almost (25/28) as long as the cymbium, which is without stout setae distally. The cymbium is rather wide, as in *borealis*, the greatest width being more than half the length, but there is a much greater space between the lamella and the cymbium proper. The median apophysis is of moderate size; the terminal apophysis is stout basally and terminates in a gently rounded point overlying the transparent membranous process.

FEMALE: For the 71 specimens examined, the total length ranged from 1.74 to 2.41 mm. Structure and general appearance typical. The epigynum shows a wide U-shaped anterior median lobe and a broad sclerotized posterior flap.

TYPE LOCALITY: Three male cotypes from Clarendon Hills, Massachusetts, November 3, 1904. Female cotype from Three Mile Island, Lake Winnepesaukee, New Hampshire, May 25, 1905, all collected by J. H. Emerton, and now deposited in the Museum of Comparative Zoölogy.

DISTRIBUTION: MAINE: Hollis, June 12, 1908 (J. H. Emerton). NEW HAMPSHIRE: North Woodstock, June 4, 1908 (J. H. Emerton), and September, 1911 (W. H. Fox); Three Mile Island, December, 1906 (J. H. Emerton); Franconia Notch, August 21, 1925. MASSACHUSETTS: Huntington, September 30, 1909; Northfield, December 30, 1905 (J. H. Emerton); Williamstown, July 30, 1908 (J. H. Emerton). CONNECTICUT: New Haven, December 15, 1882 (J. H. Emerton); Salisbury, September 4, 1939 (B. J. Kaston). NEW YORK: Ithaca, July 15, 1909 (E. B. Bryant); Danemora, October 19, 1935; Bolton, June 8, 1933 (C. R. Crosby and H. Dietrich); McLean, July 1904, and May 16, 1925; Bergen, November 1, 1928 (H. Dietrich); Peru, October 22, 1934; Trout Pond, Essex County, October 20, 1934; Potter Swamp, July 16, 1926; North Pond, Oswego County, July 27, 1935 (C. R. Crosby); Cadyville, June 9, 1933 (C. R. Crosby). PENNSYLVANIA: Edinboro, July 5, 1927 (Palmer). This species has also been reported from Indiana by Elliott (1932).

Ctenium riparius (Keyserling)

Figures 11-13, 44

Pedanostethus [sic] *riparius* KEYSERLING, 1886, Spinnen Amerikas, Theridiidae, vol. 2, p. 265, pl. 21, fig. 313, ♀.

Pedanostethus riparius MARX, 1890, Proc. U. S. Natl. Mus., vol. 12, p. 531; BRYANT, 1908, Occas. Papers Boston Soc. Nat. Hist., vol. 7, no. 9, p. 18; EMERTON, 1909, Trans. Connecticut Acad. Sci., vol. 14, p. 182 (in part), pl. 1, fig. 1-1c, ♀ ♂

(not fig. 1d); EMERTON, 1911, *ibid.*, vol. 16, pl. 1, fig. 3b, ♂; BANKS, 1910, Bull. U. S. Natl. Mus., no. 72, p. 22; PETRUNKEVITCH, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 185; COMSTOCK, 1912, Spider book, p. 365 (in part), figs. 372a, 373, ♀ ♂ (not fig. 372b); EMERTON, 1913, Appalachia, vol. 12, p. 155; BARROWS, 1918, Ohio Jour. Sci., vol. 18, p. 304; EMERTON, 1919, Trans. Roy. Canadian Inst., vol. 12, p. 313; WORLEY AND PICKWELL, 1931, Univ. Nebraska Studies, vol. 27, p. 28; ELLIOTT, 1932, Proc. Indiana Acad. Sci., vol. 4, p. 424; KURATA, 1937, Canadian Field Nat., vol. 51, p. 114; KURATA, 1939, *ibid.*, vol. 53, p. 81; KURATA, 1943, *ibid.*, vol. 57, p. 10; TRUMAN, 1942, Proc. Pennsylvania Acad. Sci., vol. 16, p. 27.

Robertus riparius CROSBY AND BISHOP, 1926, Jour. Elisha Mitchell Sci. Soc., vol. 41, p. 180; CROSBY AND BISHOP, 1928, Cornell Univ. Agr. Exp. Sta. Mem., no. 101, p. 1040; KASTON, 1938, Bull. Connecticut Geol. Nat. Hist. Surv., no. 60, p. 186; BRIMLEY, 1938, Insects of North Carolina, p. 473; COMSTOCK, 1940, Spider book, rev. ed., p. 380 (in part), figs. 372a, 373, ♀ ♂ (not fig. 372b).

Not *Pedanostethus riparius* Banks, 1907, Indiana Dept. Geol. Nat. Hist. Res., 31st Ann. Rept., p. 739.

MALE: For the 79 specimens examined, the total length ranged from 2.54 to 3.68 mm. Structure and general appearance typical as described for *banksi*, new species, with the chelicerae compressed distally. Pedipalp with patella and tibia together almost two-thirds as long as femur and about same length as cymbium, which is provided with two stout apical setae. Palpus very much as in *longipalpus* but with cymbium shorter and with median apophysis having a much shorter proximal ramus. The terminal apophysis is more abruptly bent at the apex and has two finely drawn out points overlying a distal membranous process.

FEMALE: For the 181 specimens examined, the total length ranged from 2.75 to 4.1 mm. Structure and general appearance as in male. Epigynum with a pear-shaped anterior median lobe, smaller than in the other species, and with the entire epigynum narrower than in *similis*.

TYPE LOCALITY: Eagle Harbor, Michigan (Marx Collection at the United States National Museum).

DISTRIBUTION: MAINE: Moosehead Lake, August 7, 1904 (J. H. Emerton); Presque Isle, August 26, 1925. NEW HAMPSHIRE: Intervale, August 1, 1910 (E. B. Bryant); Moosilauke, July 8, 1912 (E. B. Bryant); Mt. Washington,

June 10, 1877 (J. H. Emerton); Randolph, July 1, 1926 (J. H. Emerton), and September 10-14, 1939¹ (E. L. Bell). VERMONT: Stowe, July 22, 1902 (E. B. Bryant); Grout, July 1913 (R. V. Chamberlin). MASSACHUSETTS: Magnolia, April 19, 1906 (E. B. Bryant); Waltham, April 23, 1904 (E. B. Bryant), and November 9, 1906 (E. B. Bryant); Cohasset, June 17, 1904 (E. B. Bryant); Gloucester, November 3, 1908 (E. B. Bryant); Carlisle Pines, October 1, 1904 (J. H. Emerton), and October 26, 1907 (E. B. Bryant); Clarendon Hills, November 10, 1904 (J. H. Emerton), and September 27, 1905 (E. B. Bryant); Monponsett, June 12, 1912 (J. H. Emerton); Cambridge, April, 1906; Sudbury, October 1, 1905 (J. H. Emerton); Brookline, October 17, 1904 (J. H. Emerton); Mt. Wachusett, October 28, 1932. CONNECTICUT: New Haven, December 15, 1882 (J. H. Emerton); Watertown, April 28, 1935 (B. J. Kaston); Sherman, April 7, 1935 (B. J. Kaston); Tolles, September 26, 1936 (B. J. Kaston); Killingworth, January, 1938 (B. J. Kaston); Salisbury, September 4, 1939 (B. J. Kaston). QUEBEC: North entrance Gaspé National Park, August 8, 1940 (L. I. Davis); Pinnacle, July 22, 1913 (R. V. Chamberlin); Ellis Bay, Anticosti Island, 1919 (Brooks). ONTARIO: Port Credit, October 12, 24, 1942, and May 5, 1943 (S. Harrod); Arnprior, May, 1935 (Macnamara); Lake Openengo, July 14, 1943, Mazinau Lake, July, 1943 (Harrington); Turkey Point, June 11, 1933; Temayami, July 23, September 1, 1938; Toronto, October 2, 1938; Kingston, August 29, 1937 (T. B. Kurata); Deny River, August 11, 1937 (T. B. Kurata); Mer Bleu, June 4, 1931 (T. B. Kurata); Menaki, July 23, 1931 (T. B. Kurata); Elmhurst, August 13, 1928 (T. B. Kurata); Carnavan, May 18, 1941. NEW YORK: Ithaca, May 23 (N. Banks), December 29, 1912, November 19, 1925, October 17, 1934; Jamesville, October, 1900 (H. W. Britcher); Keene Valley, May 26, 1916 (H. Notman); Wilmington Notch, August 21, 1916 (J. H. Emerton); Michigan Mills, September 1, 1926; Indian Lake, October 19, 1934; Adirondack Lodge, July 24, 1925; Brant Lake, October 19, 1934; Speculator, October 19, 1934; Taughanock Falls, May 11, 1930; Mt. Marcy, August 25, 1930 (C. R. Crosby); Sea Cliff (N. Banks); Cold Spring Harbor, April 10, 1905 (E. B. Bryant). NEW JERSEY: Schooley Mountain, May 23, 1910; Newfoundland, May 29, 1910; Ramsey, June 12, 1912; Sussex County, June 19, 1945 (C. and M. Goodnight). PENNSYLVANIA: Conyngham. NORTH CAROLINA: Black Mountain. TENNESSEE: Klingman's Dome, June 25, 1936 (W. M. Barrows). MICHIGAN: Powers, July 4, 1910 (R. V. Chamberlin); Montmorency County, December 22, 1942 (J. W. Leonard); Thumb Lake, September 19, 1932 (A. M. Chickering); Mosherville, September 30, 1939 (A. M. Chickering); Marquette, July 2, 1932 (A. M. Chickering); Werner Lake, August 13, 1927 (A. M. Chickering). MINNESOTA: Lake

Minnetonka, June 22, 1926 (F. C. Fletcher). SOUTH DAKOTA: Hill City (Marx Collection). WYOMING: Yellowstone Park, August 14, 1927 (R. V. Chamberlin). This species has also been recorded from Ohio by Barrows (1918), from Nebraska by Worley and Pickwell (1931), and from Indiana by Elliott (1932).

Ctenium similis, new species

Figure 45

FEMALE: Total length, 3.35 mm. Structure and general appearance typical as described for *banksi*, new species. The epigynum most nearly resembles *riparius*, but besides having the anterior median lobe longer and differently shaped the receptacles are farther back and the entire epigynum is wider than in that species, as can be seen by a comparison of figures 44 and 45.

TYPE LOCALITY: Female holotype from Ithaca, New York (Nathan Banks Collection).

Ctenium spiniferus (Emerton)

Figures 23-25, 57

Pedanostethus spiniferus EMERTON, 1909, Trans. Connecticut Acad. Sci., vol. 14, p. 183, pl. 1, fig. 3-3b, ♀ ♂; EMERTON, 1911, *ibid.*, vol. 16, pl. 1, fig. 3c, ♂; BANKS, 1910, Bull. U. S. Natl. Mus., no. 72, p. 22; PETRUNKEVITCH, 1911, Bull. Amer. Mus. Nat. Hist., vol. 29, p. 185.

Robertus spiniferus CROSBY and BISHOP, 1928, Cornell Univ. Agr. Exp. Sta. Mem., no. 101, p. 1040.

MALE: For the seven specimens examined, the total length ranged from 2 to 2.14 mm. Structure and general appearance typical as described for *banksi*, new species, but as in *eremophilus* the promargin of the fang furrow apparently has only two teeth and the chelicerae are not compressed distally. Pedipalp with patella and tibia together two-thirds as long as the femur and seven-eighths as long as the cymbium. The tibia alone is quite short, shorter than in most species. The cymbium is quite broad and is not provided with any stout distal setae. The lamella is small, and there is very little space between it and the cymbium proper. The most characteristic feature of the palpal organ is the extreme development of the median apophysis. The distal ramus is relatively narrow, but the proximal ramus forms a very

¹ Including a male that is completely without eyes!

long ventrally directed hook, broad at its base (fig. 23). The terminal apophysis is comparatively small, as in *eremophilus*, and ends in a sharp point turned toward the distal membranous process.

FEMALE: For the 13 specimens examined, the total length ranged from 1.95 to 2.68 mm. Structure and general appearance as in male, with apparently only two promarginal teeth on the chelicerae. The epigynum is relatively quite long in this species, being as long as that part of the venter between it and the spinnerets, or longer. There is a dark median anterior area, a pair of receptacles behind this, and a pair of tubules extending from the receptacles to the posterior border. A bluntly pointed unpigmented process extends behind this.

TYPE LOCALITY: Male cotype from Clarendon Hills, Massachusetts, November 3, 1904; female cotype from Waltham, Massachusetts, April 1, 1908, both collected by J. H. Emerton, and now deposited in the Museum of Comparative Zoölogy.

DISTRIBUTION: NEW HAMPSHIRE: Three Mile Island, Lake Winnepesaukee, May 15, 1916 (J. H. Emerton). MASSACHUSETTS: Holliston, March 25, 1924 (J. H. Emerton); Allston, November 9, 1905 (E. B. Bryant); Waltham, November 9, 1906 (E. B. Bryant). CONNECTICUT: Harwinton, July 16, 1938 (B. J. Kaston). MICHIGAN: Bath Mills, May 11, 1933 (A. M. Chickering); Albion, January 20, 1933 (A. M. Chickering). IOWA: Ames, fall of 1932 (H. B. Mills). NEBRASKA: near Nebraska City, June 7, 1933 (W. Ivie); "Nebraska" (Marx Collection at the United States National Museum). This species has also been listed from New York by Crosby and Bishop (1928).

Ctenium vigerens (Chamberlin and Ivie)

Figures 9, 10, 29-31, 55

Garrilus vigerens CHAMBERLIN AND IVIE, 1933, Bull. Univ. Utah, vol. 23, no. 4, biol. ser. vol. 2, no. 2, p. 9, pl. 2, figs. 10-20, ♀ ♂.

MALE: For the nine specimens examined, the total length ranged from 2.75 to 3.63 mm. Structure and general appearance typical as described for *banksi*, new species, except for the marked development of the mouthparts (figs. 9 and 10). The chelicerae are strongly geniculate and quite robust, not compressed distally. Of the three promarginal teeth the ectalmost is the largest and is much higher up and nearer

the base of the fang than in the other species. The endites are more swollen apically than in the other species, and the setiferous granules are more conspicuous. Pedipalp with patella and tibia together eight-tenths as long as the femur and considerably longer (45/35) than the cymbium. The tibia alone is quite long, being six-sevenths the length of the cymbium. The latter is provided apically with four very stout setae. Along the edge of the cymbium just proximal to the base of the lamella is a row of five conspicuous, closely set hairs. The lamella arises rather far from the tip of the cymbium and is abruptly turned toward the palpal organ. The median apophysis is of moderate size and has a rather heavy proximal ramus. The terminal apophysis is only weakly developed, but the distal membranous transparent process is quite large and conspicuous.

FEMALE: For the 38 specimens examined, the total length ranged from 2.88 to 4.5 mm. Structure and general appearance as in the male, with the chelicerae and endites swollen. The epigynum shows a pair of receptacles anterior to a raised lip, posterior to which is a shallow fossa.

TYPE LOCALITY: A male and two female cotypes from the Raft River Mountains, Utah, September, 1932, collected by W. Ivie (deposited in the collection of the University of Utah).

DISTRIBUTION: ALASKA: Admiralty Island, June, 1933 (Sheppard). BRITISH COLUMBIA: Vernon, August 1931; Kelowna, September, 1931; Terrace, March, 1933 (Hippisley), March, 1937 (W. E. Clark); Prince Rupert, June 22, 1936 (C. R. Crosby); Lake Cameron, Vancouver Island, September 13, 1935 (Chamberlin and Ivie). WASHINGTON: Mt. Ranier Park, July 5-6, 1938 (W. Ivie), July 10-12, 1942 (B. Malkin); Olympia; Bay Center, August 1, 1931 (Kincaid); Easton, August 10, 1929 (R. V. Chamberlin); Snoqualmie Pass, September 16, 1935 (Chamberlin and Ivie). OREGON: Waldport, June 11, 1936 (C. R. Crosby); Ashland, September 9, 1935 (Chamberlin and Ivie); Three Rocks, May 31, 1942 (J. C. Chamberlin); Scott Lake, Lane County, August 17, 1941 (B. Malkin). CALIFORNIA: San Francisco, December 20, 1919 (H. Dietrich); Weed, September 8, 1935 (Chamberlin and Ivie). IDAHO: Coeur d'Alene, August 11, 1929 (R. V. Chamberlin);

¹ In a personal communication to the author Ivie stated that the listing of Wisconsin at the time of the original description was an error.

Lost Lake, August 20, 1936, and July 27, 1939 (W. Ivie); Mesa, July 2, 1943 (W. Ivie). MONTANA: Hellgate River, August 13, 1929 (R. V. Chamberlin). УТАХ: Verdure, May 10, 1933 (W. Ivie); Salt Lake City, September, 1932, and September 16, 1942 (W. Ivie); Raft River Mountains, September 6, 1932 (E. G. Berry).

Chamberlin and Ivie erected their genus *Garritus* on the basis of the enlarged chelicerae and endites in *vigerens*. But an intermediate condition is seen in *floridensis*, and it will probably be agreed that a new genus is not justified.

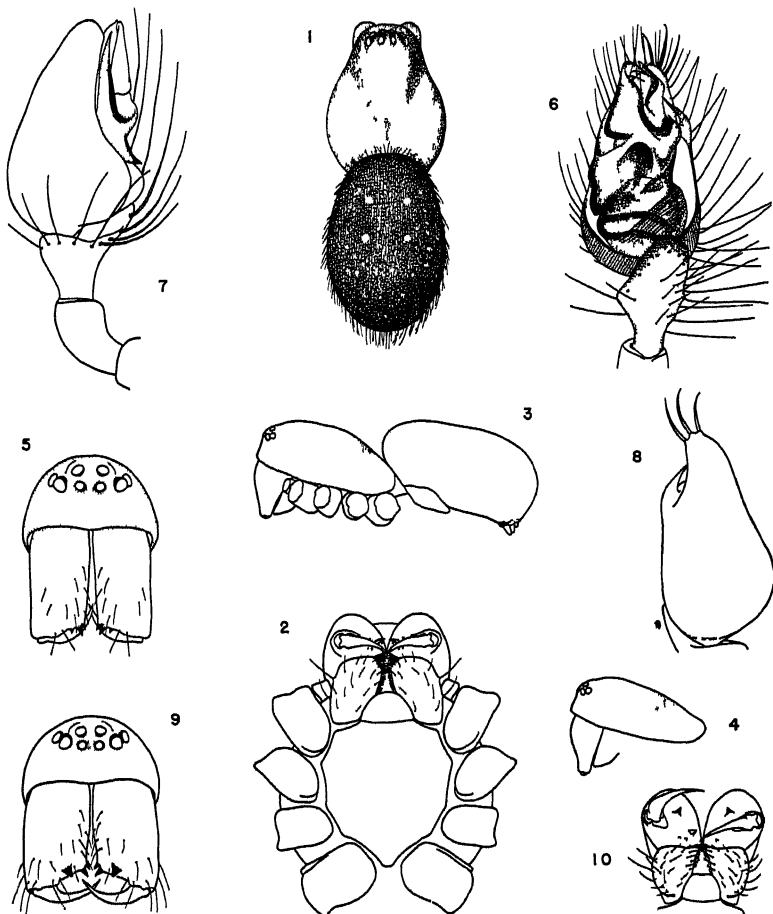
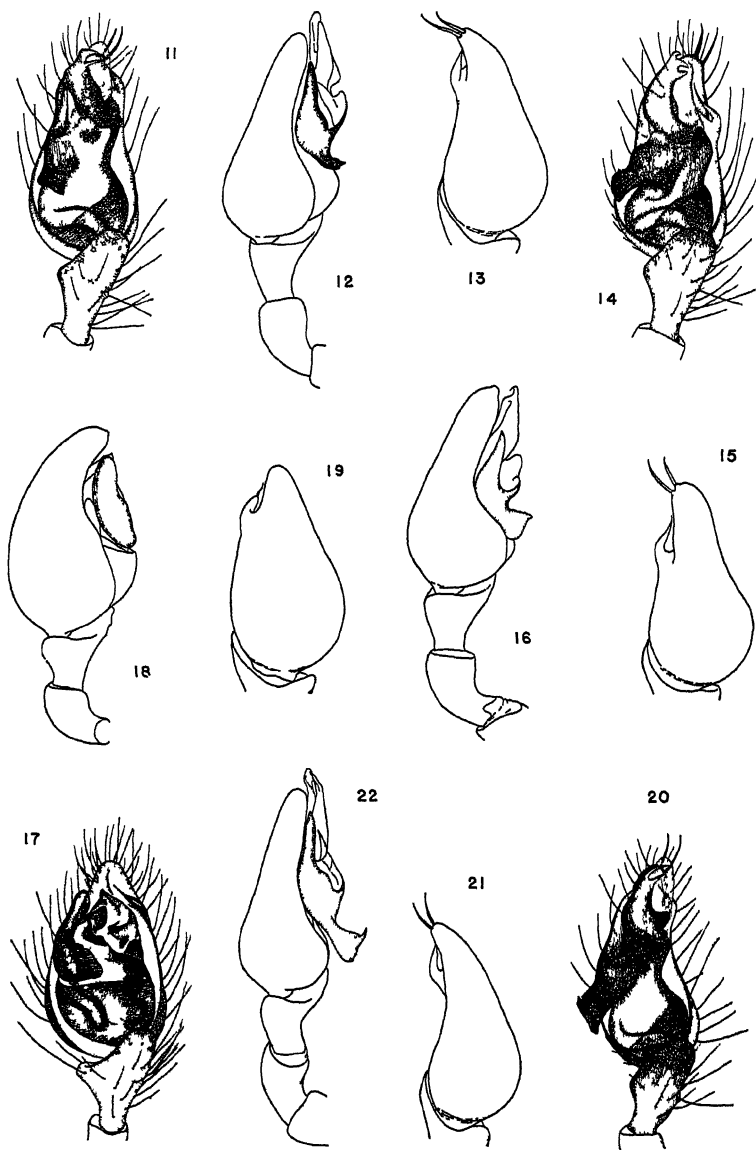


Fig. 1. *Ctenium banksi*, new species, dorsal aspect of female.
 Fig. 2. Idem, ventral aspect of cephalothorax.
 Fig. 3. Idem, lateral aspect of body.
 Fig. 4. Idem, lateral aspect of cephalothorax of male.
 Fig. 5. Idem, face of female.
 Fig. 6. Idem, palpus, ventral aspect.
 Fig. 7. Idem, palpus, lateral aspect.
 Fig. 8. Idem, palpus, dorsal aspect.
 Fig. 9. *Ctenium vigerens* (Chamberlin and Ivie), face of female.
 Fig. 10. Idem, ventral aspect of mouthparts.



- Fig. 11. *Ctenium riparius* (Keyserling), palpus, ventral aspect.
 Fig. 12. Idem, palpus, lateral aspect.
 Fig. 13. Idem, palpus, dorsal aspect.
 Fig. 14. *Ctenium laticeps* (Keyserling), palpus, ventral aspect.
 Fig. 15. Idem, palpus, dorsal aspect.
 Fig. 16. Idem, palpus, lateral aspect.
 Fig. 17. *Ctenium livida* (Blackwall), palpus, ventral aspect.
 Fig. 18. Idem, palpus, lateral aspect.
 Fig. 19. Idem, palpus, dorsal aspect.
 Fig. 20. *Ctenium longipalpus*, new species, palpus, ventral aspect.
 Fig. 21. Idem, palpus, dorsal aspect.
 Fig. 22. Idem, palpus, lateral aspect.

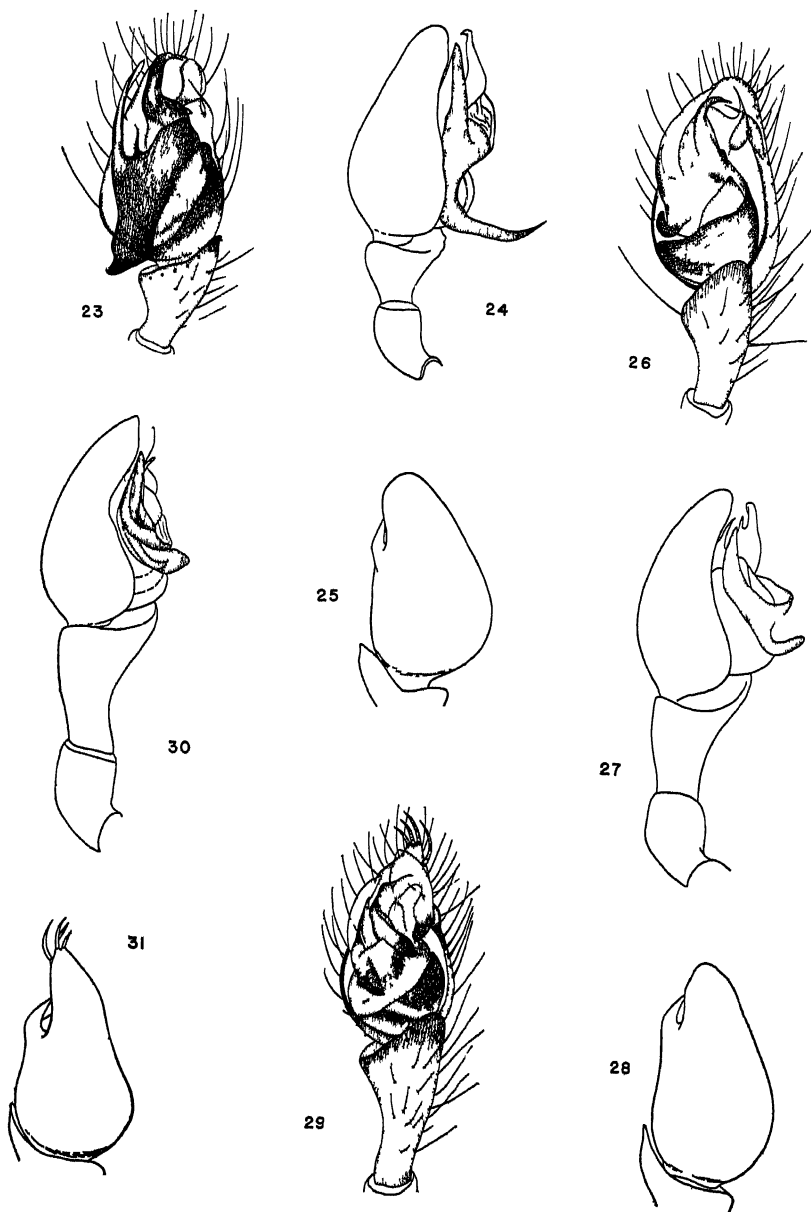
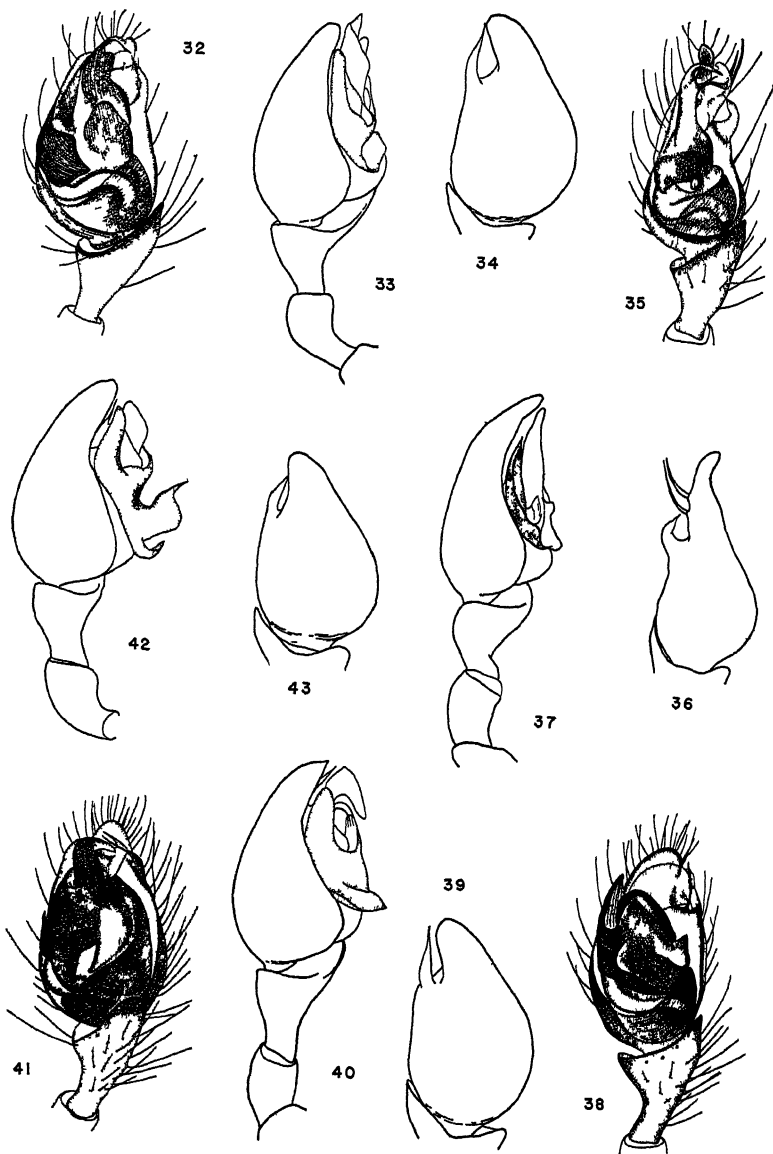
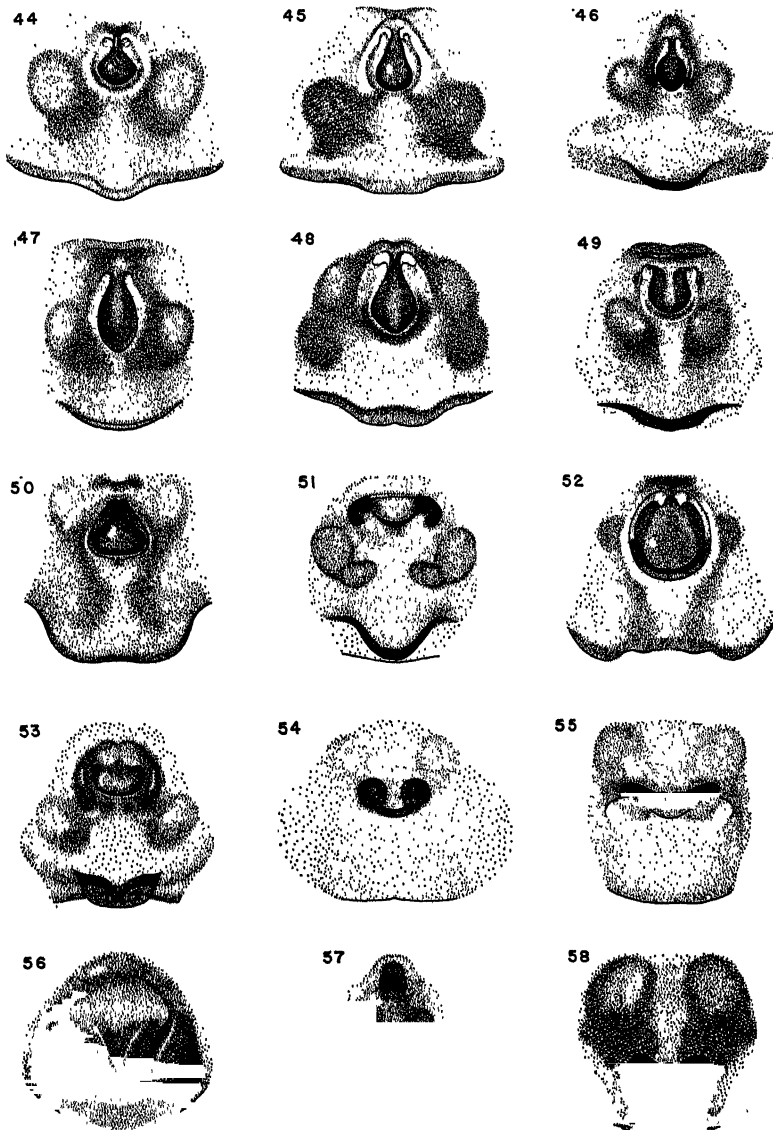


Fig. 23. *Ctenium spiniferus* (Emerton), palp, ventral aspect.
 Fig. 24. Idem, palp, lateral aspect.
 Fig. 25. Idem, palp, dorsal aspect.
 Fig. 26. *Ctenium eremophilus* (Chamberlin), palp, ventral aspect.
 Fig. 27. Idem, palp, lateral aspect.
 Fig. 28. Idem, palp, dorsal aspect.
 Fig. 29. *Ctenium vigerens* (Chamberlin and Ivie), palp, ventral aspect.
 Fig. 30. Idem, palp, lateral aspect.
 Fig. 31. Idem, palp, dorsal aspect.



- Fig. 32. *Ctenium pumilus* (Emerton), palp, ventral aspect.
 Fig. 33. Idem, palp, lateral aspect.
 Fig. 34. Idem, palp, dorsal aspect.
 Fig. 35. *Ctenium frontata* (Banks), palp, ventral aspect.
 Fig. 36. Idem, palp, dorsal aspect.
 Fig. 37. Idem, palp, lateral aspect.
 Fig. 38. *Ctenium fusca* (Emerton), palp, ventral aspect.
 Fig. 39. Idem, palp, dorsal aspect.
 Fig. 40. Idem, palp, lateral aspect.
 Fig. 41. *Ctenium borealis*, new species, palp, ventral aspect.
 Fig. 42. Idem, palp, lateral aspect.
 Fig. 43. Idem, palp, dorsal aspect.



- Fig. 44. *Ctenium riparius* (Keyserling), epigynum.
 Fig. 45. *Ctenium similis*, new species, epigynum.
 Fig. 46. *Ctenium laticeps* (Keyserling), epigynum.
 Fig. 47. *Ctenium longipalpus*, new species, epigynum.
 Fig. 48. *Ctenium floridensts*, new species, epigynum.
 Fig. 49. *Ctenium banksi*, new species, epigynum.
 Fig. 50. *Ctenium borealis*, new species, epigynum.
 Fig. 51. *Ctenium frontata* (Banks), epigynum.
 Fig. 52. *Ctenium crosbyi*, new species, epigynum.
 Fig. 53. *Ctenium pumilus* (Emerton), epigynum.
 Fig. 54. *Ctenium eremophilus* (Chamberlin), epigynum.
 Fig. 55. *Ctenium vigerens* (Chamberlin and Ivie), epigynum.
 Fig. 56. *Ctenium fusca* (Emerton), epigynum.
 Fig. 57. *Ctenium spiniferus* (Emerton), epigynum.

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ANNOTATED FAUNAL LIST OF THE GLEN DEAN FORMATION OF CRANE, INDIANA¹

By OTTO HAAS

INTRODUCTION

The study of the fossils collected at Crane, Indiana, having been completed, publication of a comprehensive faunal list of the Glen Dean formation in that part of southwestern Indiana appears to be desirable.

By way of introduction, a few words on the localities and their stratigraphy might be expedient. Collections were made at several localities, most of them deserted quarries within a perimeter of from one-half to two-thirds of a mile around the road junction called Sargent's Corner (about 2½ miles due south of the east end of Lake Greenwood) in Martin County, Indiana. These quarries were assigned the numbers I and Ia, both of them northwest, and II, IIa, IIb, and IIc, all southwest of Sargent's Corner, respectively. One more locality, called "III," is about 1½ miles southwest of that point, directly across the

road from the South Transfer Depot of the Naval Ammunition Depot at Crane. The elevation of all these localities is between 550 and 700 feet above sea level.

The Glen Dean, which is the top formation of the Middle Chester or, to use a new term introduced by J. M. Weller and A. H. Sutton (1940), of the Homberg group, attains in these localities thicknesses up to 40 or 50 feet. It consists chiefly of limestone, with some interbedded shales in the lower portion of the formation, whereas it assumes a dense, cherty facies in its uppermost layers. The formation overlies the Hardingsburg sandstone and is conformably overlain by the plant bearing Tar Springs sandstone, basal formation of the Upper Chester (Elvira group). Except for a slight dip toward the south or southwest, the strata appear to be flat and undisturbed throughout the area.

FAUNAL LIST

Faunistically, slight differences are found between the various localities, certain groups of fossils being more abundant in one than in the other. On the whole, however, the formation may be considered a faunistic as well as a stratigraphic unit throughout the area. Therefore, no differentiation as to localities is made in the following faunal list. Forms particularly common, which thus may serve as index fossils for the formation in that area, are preceded by a "c," those particularly rare by an "r"; these symbols should, however, be understood in a relative sense, indicating

the abundance or rarity, respectively, of certain forms within the major group rather than within the fauna as a whole.

ANTHOZOA

TRIPLOPHYLLITES EASTON

c *T. spinulosus* (Milne Edwards and Haime)

VERMES

SPIRORBIS DAUDIN

S. annulatus Hall ?

BLASTOIDEA

PENTREMITES SAY

This genus, as represented at the localities concerned, has been explicitly discussed in Haas, 1945a.

¹ Third report on the results of the writer's collecting trip to Crane, Indiana, in October, 1944, for the first and second reports see American Museum Novitates nos. 1289 and 1302.

The forms recognized are here enumerated merely for the sake of uniformity.

- c *P. spicatus* Ulrich, forma typica
- P. spicatus* Ulrich, var. *porrecta* Haas
- r *P. spicatus* Ulrich, var. *altipelvis* Haas
- r *P. cherokeensis* Hall
- P. elegans* Lyon
- P. pyramidatus* Ulrich
- P. okavensis* S. Weller
- c *P. lyoni* Ulrich, forma typica
- c *P. lyoni* Ulrich, var. *gracilens* Ulrich
- P. brevis* Ulrich
- r *P. cf. brevis* Ulrich
- r *P. hambachi* Butts?
- P. spec.* indet.

One of the specimens here included (A.M.N.H. No. 26071:1) shows clearly the hydrospires; another (on large slab A.M.N.H. No. 26167) has the pinnules preserved.

CRINOIDEA

ZEACRINITES TROOST

- r *Z. wortheni* (Hall)
- Calyx with stalk.

THOLOCRINUS KIRK

- r *T. spec.*

Crushed ventral sac of an unusually large individual¹ (A.M.N.H. No. 26076).

AGASSIZOCRINUS OWEN AND SHUMARD

- r *A. spec.*
- Infrabasal cones.

Crinoidea, genus and spec. indet.

Stems, fragments and links thereof, the first including some unusually long (up to 15 cm.) ones, one of them twisted.

ECHINOIDEA

Genus and spec. indet.

Detached spines.

¹ After completion of the present manuscript an otherwise very similar but much larger head of *Tholocrinus* from quarry "1a," measuring about 75 mm. in height and about 90 mm. in width, was sent in and generously presented to the American Museum of Natural History by Lieut. W. N. Dale. Whereas the individual listed above might well be conspecific with the specimens of *T. wetherbyi* Wachsmuth and Springer figured by Springer (1926, pl. 25, figs. 4-12), the one here dealt with (A.M.N.H. No. 26198) seems such a giant, when compared with those figures, that it may have to be referred to an independent species.

BRYOZOA

BATOSTOMELLA ULRICH

- B. nitidula* Ulrich

STENOPORA LONSDALE

- S. tuberculata* (Prout)
- S. cestriensis* Ulrich
- r *S. ramosa* Ulrich
- S. spec.*

ANISOTRYPA ULRICH

- r *A. ? spec.*

This form, represented by a single well-preserved colony only, might be the Chester species growing in hollow branches, mentioned but not described or figured by Ulrich (1890, p. 448). Even its generic reference remains, however, doubtful; no ridges can be seen between the openings which are about twice as large as in *A. solida* Ulrich.

LIOCLEMA ULRICH

- r *L. cf. araneum* Ulrich

The three colonies found in the present material deviate from Ulrich's (1890, p. 431, pl. 75, fig. 9-9c) merely by having only six to eight instead of nine to 10 zoecia on a width of 2 mm. The apertures may be subcircular in shape as well as oval, as stated in Ulrich's description, but to judge by his figure 9 this is equally true for his type.

ERIDOPORA ULRICH

- c *E. macrostoma* Ulrich

One colony (on slab A.M.N.H. No. 26130), selected as hypotype, is remarkable for its strong resemblance to Ulrich's protograph (1882, pl. 6, fig. 2).

- r *E. punctifera* Ulrich

FENESTRELLINA D'ORBIGNY (= FENESTELLA AUCTT.)

Pending Condra and Elias' application to the International Commission on Zoological Nomenclature for the retention of the generic name *Fenestella* Lonsdale, not Bolton (see Condra and Elias, 1941;

1944, p. 18), the name *Fenestrellina* is here used for the forms concerned, as suggested by Bassler. This, however, solves only the formal nomenclatorial problem. Even more complex is the other, which is biological as well as taxonomic and which results from the fact, emphasized in an earlier report (Haas, 1945b, p. 4), that in the Chester series bryozoan meshworks, conspecific with each other, are found radiating from *Archimedes* screws as well as in the appearance of foliate expansions without any connection with such screws. According to McFarlan (1942, p. 444) "the bulk of Fenestellid fronds so common in Chester limestones" has to be referred "to the genus *Archimedes*" and "only *F. cestriensis* and *F. exigua*" are recognized by him "as true *Fenestrellina* with any degree of certainty." Condra and Elias (1944, p. 61), on the other hand, take the following attitude: "... since several American species of *Fenestella* are encrusted by essentially the same fibrous tissue as observed in *Archimedes* and no screws have been found with them, and because some *Archimedes* screws are found as superstructures upon *Fenestella* zoaria, only the fronds of *Fenestella* type attached to flanges of a screw or reasonably proved to be their broken portions—but not when they belong to *Fenestella* colony which served as its base—should be classified as *Archimedes*. In doubtful cases the fragments of *Fenestella* types should be placed rather in the genus *Fenestella* than in *Archimedes*." This recommendation has been followed in the course of the present study.

c *F. cf. cestriensis* (Ulrich)

The specimens from Crane differ from Ulrich's (1890, p. 597) original description by having from 12 to 16—instead of an average of 10—fenestrules to 1 cm.

F. tenax (Ulrich)

F. serratula (Ulrich)

F. spec.

ARCHIMEDES (LESUEUR) OWEN

Observations on some remarkable specimens of this genus from Crane and on the genus as such were published in an earlier report (Haas, 1945b). Here follows the enumeration of the various forms recognized in the present material.

c *A. invaginatus* Ulrich

A. invaginatus Ulrich, var.

A single short screw fragment (A.M.N.H. No. 26097), distinguished by extraordinarily wide flanges, attaining up to 15 mm. in diameter, and by having only two (instead of 3.7–5) volutions to 2 cm.

A. swallowanus Hall

An almost perfectly straight screw (A.M.N.H. No. 26099:1), exhibiting 26 volutions, but still incomplete, attains 115 mm. in length.

A. cf. swallowanus Hall

Some microstructural characters of the frond (studied on reverse side only) deviate somewhat from Ulrich's (1890, p. 574) description.

r *A. lativolvis* Ulrich

A short screw fragment (A.M. N.H. No. 26101:2) referred to this species is remarkable for showing on the reverse surface of the flange of its lower volution an almost complete pillar and the stumps, or at least traces, of 10 more which are partly or entirely broken off. Another short screw fragment (A.M. N.H. No. 26168) exhibits a height of the only volution observable of as much as 5 mm., and its upper flange is extraordinarily expanded on one side so as to reach a diameter of almost 20 mm. Even disregarding this extraordinary expansion, the flange still measures nearly 15 mm. in diameter. For both these deviations from the dimensions hitherto observed in the screws of *A. lativolvis*, this fragment is only doubtfully referred to Ulrich's species. Both the fragments here discussed

show excellently the fine striation of the fibrous tissue as discussed (pp. 30-33) and repeatedly illustrated (pl. 2, fig. 2, pl. 3, fig. 2, pl. 4, fig. 7, pl. 6, figs. 1-3, pl. 11, figs. 4-7, pl. 37, fig. 3) by Condra and Elias, 1944.

A. intermedius Ulrich, emend. McFarlan

A. terebriformis Ulrich

r *A. meekanus* Hall

A. meekanoides McFarlan

A. macfarlani Condra and Elias

All the screws from Crane referred to this species resemble Ulrich's (1890, pl. 63) figure 11b much more closely than his figure 11, which is, however, designated the holotype by Condra and Elias (1944, p. 150).

A. distans Ulrich

Hypotype (A.M.N.H. No. 26108) remarkable for its close resemblance to the specimen depicted by Ulrich (1890, pl. 63) in figure 9b, designated lectotype by Condra and Elias (1944, p. 117).

r *A. distans* Ulrich, var.

The few specimens referred to this unnamed variety, all of them on the two large slabs A.M.N.H. Nos. 26166 and 26167, deviate from the typical form of this species merely by their far more tender screws, with three volutions to a length of 1 cm. (instead of 2 cm., as in the former).

r *A. latus* Ulrich ?

Only one rather scanty fragment is doubtfully referred to this species.

A. spec.

POLYPORA M'Coy

P. cestriensis Ulrich

P. tuberculata Prout

r *P. spinulifera* Ulrich

P. spec.

SEPTOPORA PROUT

r *S. subquadrans* Ulrich

Among the few specimens referable to this species a foliate, slightly wrinkled expanse from quarry "Ia" (A.M.N.H. No. 26115:1) is remarkable for its size; as preserved, it

attains approximately 12 cm. in length and 9 cm. in width.

S. cestriensis Prout

RHOMBOPORA MEEK

c *R. armata* Ulrich

A bifurcating branch of particularly fine preservation (on slab



Fig. 1. *Rhombopora armata* Ulrich, hypotype, on slab A.M.N.H. No. 26150. Glen Dean limestone. Locality "III," Crane, Martin County, Indiana. Photomicrograph, $\times$ ca. 5. Lowest part of specimen not seen in photomicrograph. Note paired arrangement of spines, chiefly on main stem; some spines visible in profile.

A.M.N.H. No. 26150) is selected as hypotype and shown in figure 1.¹

c *R. minor* Ulrich

r *R. tabulata* Ulrich

R. tenuirama Ulrich

R. spec.

STREBLOTRYPA ULRICH

S. nicklesi Ulrich

The hypotype, a Y-shaped branch on slab A.M.N.H. No. 26154, is excellently preserved and, therefore, shown in figure 2.¹

PRISMOPORA HALL

r *P. serrulata* Ulrich

BRACHIOPODA

ORTHOTETES FISCHER

r *O. kaskaskiensis* (McChesney)

One of the few specimens present (A.M.N.H. No. 26175) approaches in the character of ornamentation the one figured by S. Weller (1914, pl. 6, fig. 15) under the designation *O. kaskaskiensis* (?).

¹ For permission to use the facilities of the Geological Department of Columbia University for these photomicrographs, which were painstakingly taken by Mrs. Catherine S. Seymour, I am greatly indebted to Profs. Marshall Kay and H. N. Coryell.



Fig. 2. *Streblotrypa nichlesi* Ulrich, hypotype, on slab A.M.N.H. No. 26154. Glen Dean limestone. Locality "III," Crane, Martin County, Indiana. Photomicrograph, $\times$ ca. 10. Unfortunately the half-tone does not show the small pores surrounding the zoecial apertures as distinctly as does the original photomicrograph.

LINOPRODUCTUS CHAO

Found in quarries "II" and "IIc" only.

L. ovatus (Hall)¹

S. Weller's (1919, p. 132, pl. 16, figs. 1-15) conception of this species is here followed; accordingly *L. pileiformis* (McChesney) is considered a synonym of Hall's species.

L. ovatus (Hall), var. ? (A.M.N.H. No. 26178)

In a ventral valve otherwise agreeing with the typical specimens referred to *L. ovatus*, the width is only slightly more than two-thirds of its convexity, as compared to a ratio of six to five according to S. Weller's (1914, p. 133) measurements. The same extremely narrow shape is found in a considerably smaller, incomplete ventral valve. However, it cannot be safely excluded that this deviation in shape might be due only to crushing.

DIAPHRAGMUS Girty

D. elegans (Norwood and Pratten)

A few specimens have not only spine bases, as mentioned by Weller (1914, p. 137), but well-developed, though fine spines preserved on the postero-lateral slopes of the ventral valves.

STENOSCISMA CONRAD²

S. explanata (McChesney)

Found in quarries "I" and "IIc" only.

DIELASMA KING

r *D. shumardanum* (Miller)

A single specimen present.

SPIRIFERINA D'ORBIGNY

S. transversa (McChesney)

RETICULARIINA FREDERICKS

c *R. spinosa*³ (Norwood and Pratten)

Two specimens (A.M.N.H. No. 26184/1) are worth mentioning for having the sinus of the ventral valve, or at least its posterior part, marked by a straight row of spines along the median line.

SPIRIFER SOWERBY

S. increbescens Hall, var.

This characteristic species is represented at Crane by the smaller and more delicate variety stated by Weller (1920, pp. 374-375) to be characteristic of the Lower and Middle Chester faunas, even apparently full grown shells in the present material never exceeding 18 mm. in length and 25 mm. in width, as compared to lengths of 31 and 28 mm., respectively, and widths of 40 and 44 mm., respectively, recorded by Weller (1914, p. 343) for typical shells of this species, as occurring in the Upper Chester. That author (1920, p. 374) points out that "in much of the past literature the name *S. increbescens* has been applied to all of these shells in the Chester faunas." The form listed under this name by Ulrich (1917, p. 229, No. 130) from all of his Glen Dean localities may, therefore, well be the same as that occurring at Crane.

TORYNIFER HALL AND CLARKE

*T. setiger*⁴ (Hall)

² Antedates *Camarophoria* King, mostly quoted "*Camarophoria*" in previous literature.

³ Mostly quoted as *Spiriferina spinosa* in previous literature.

⁴ Mostly quoted as *Reticularia setigera* in previous literature.

¹ Quoted as *Productus ovatus* Hall in previous literature.

CLEIOTHYRIDINA BUCKMAN

c *C. sublamellosa* (Hall)r *C. sublamellosa* (Hall), var. (A.M.N.H. Nos. 26190, 26190/1)

Deviates from the typical form by its unusual width, amounting to about five-fourths of the length, as compared to twenty-one-twentieths only in the average specimen measured by S. Weller (1914, p. 483).

COMPOSITA BROWN

C. trinuclea (Hall)

S. Weller's (1914, p. 486; 1920, pp. 354, 361) conception of this species is here followed. Its high variability, as pointed out by that author, is fully confirmed by the material from Crane which includes most of the various forms illustrated in Weller's (1914) plate 81. The hypotype (A.M.N.H. No. 26191/1:1) is closely reminiscent of the "very perfect specimen" shown in his figures 16-20 of that plate; another fine shell from quarry "II" (A.M.N.H. No. 26191/1:2) of that shown in his figures 25, 26; still another (A.M.N.H. No. 26191/1:3) of the comparatively large shell represented in Weller's figures 31-34, as is a shell from quarry "I" (A.M.N.H. No. 26191:2). Still another specimen from the latter locality (A.M.N.H. No. 26191:1) closely resembles the narrow form illustrated in Weller's figures 35 and 36, whereas a few smaller shells from quarry "II" (A.M.N.H. No. 26191/1:4-6) stand out by being unusually wide. Some more, rather small individuals from quarries "I," "II," and "IIb" (A.M.N.H. Nos. 26191:3, 26191/1:7, 8, 26191/2) represent the more delicate form illustrated by Weller's figures 27-30.

r *C. subquadrata* (Hall) (A.M.N.H. No. 26192)

A single shell, attaining 21.3 mm. in length, 20.6 mm. in width, and 12.1 mm. in thickness, resembles in its size as well as in its shape so closely the specimens referred by S.

Weller (1914, p. 489, pl. 81, figs. 1-15; 1920, p. 375, pl. 11, figs. 12-14) to the true *C. subquadrata*, especially those illustrated in plate 81, figures 9-11, and plate 11, figures 12, 13, that it has to be assigned to that species, despite Weller's tendency (1920, p. 375) to restrict it to the Upper Chester. However, the boundary between *C. trinuclea* and *C. subquadrata* appears to be a fluent one. The specimen here dealt with may well be one of those which, in Weller's (1920, p. 354) words, "are intermediate in character between any of the groups that may be recognized."

r *C. laevis* S. Weller

Represented by a single individual.

r *C. spec.*

PELECYPODA

CANEYELLA GIRTY

C. ? spec.

On the strength of its resemblance to some of Girty's (1909, pl. 3) figures of his *C. wapanuckensis*, especially figures 8 and 10, the only pelecypod from Crane, rather poorly preserved and measuring about 9 mm. in length, is tentatively identified as above.

GASTROPODA

PLATYCERAS CONRAD; SUBGENUS ORTHONYCHIA HALL

c *P. (O.) spec.*

STRAPAROLUS MONTFORT; SUBGENUS EUOMPHALUS SOWERBY

r *S. (E.) planidorsatus* Meek and Worthen?

r Bellerophonitid gastropod

r High-spined gastropods, somewhat reminiscent of *Ceraunocochlis* Knight, gen. and spec. indet.¹r High-spined gastropod (cf. *Ceraunocochlis* Knight), or echinoid spine?

¹ For determination of these gastropods and valuable suggestions for that of some of the others and of the specimens here doubtfully referred to *Spirorbis annulatus* Hall, I am greatly indebted to Dr. J. Brookes Knight, of the United States National Museum.

Differs from the high-spined gastropods listed above, which attain heights of from 3 to 5 mm. only, chiefly by its much larger size, attaining about 15 mm. in height.

r Gastropod, gen. and spec. indet.

Also small (may have reached a height of 6 or 7 mm.), but generically different from those listed above.

r Gastropods, gen. and spec. indet.

Of similarly small size.

TRILOBITA

KASKIA J. M. WELLER

K. chesterensis S. Weller and J. M. Weller (= ? *Phillipsia stevensoni* Meek)

Except for one poorly preserved but complete individual, the nine specimens present are pygidia only. I wish to extend my thanks to Dr. J. Marvin Weller of the Illinois State Geological Survey for his identification of this form. In a letter dated Urbana, March 6, 1945, Dr.

Weller repeats the view, previously stated in his paper on Carboniferous trilobite genera (1936, p. 710), that *K. chesterensis* might be a synonym of *Phillipsia stevensoni*. As a matter of fact, pygidia from Pennsylvania and Alabama, labeled *Phillipsia stevensoni* Meek in the collections of the American Museum of Natural History (two of them from the Hall collection, the others presented by Prof. J. J. Stevenson), are indistinguishable from the Crane specimens, as are those given by the same donor to Walker Museum from J. M. Weller's types (see Weller, 1936, p. 711). In his letter, quoted above, he believes conspecificity of "*Phillipsia*" *stevensoni* and *Kaskia chesterensis* even to be probable, but he hesitates to replace the latter specific name by the former because Meek's species has never been adequately described and figured, and the types cannot be located.

Pygidium of an indeterminate trilobite

STRATIGRAPHICAL CONCLUSIONS

If the present faunal list is compared with Ulrich's (1917, pp. 226-230) of the Glen Dean formation, which seems to be so far the most complete one given for that formation, it cannot be surprising that Ulrich's list, covering "four collections taken from as many widely separated places in Kentucky" and including for the sake of correlation western Illinois, enumerates many more forms (altogether 162) than the Crane list which deals with one limited area and includes altogether 86 forms.

On the other hand, if slight differences as indicated by a "cf." preceding, or a "var." following the specific name are neglected on either side and if the small gastropods from Crane which could not be reliably determined even as to their generic affinities are left out of account, the names listed above are, with comparatively few exceptions, found in Ulrich's list as well.

Most of these exceptions are, however,

not real ones: Ulrich's "*Zaphrentis spinulifera*" is merely a synonym of *Triplophylites spinulosus*. My varieties of *Pentremites spicatus* are mentioned though not named in Ulrich's paper of 1917. *P. lyoni*, var. *gracilens* Ulrich is not included in his list, but this variety is recorded by him (1917, p. 263) "from either the Golconda or the Glen Dean limestone in . . . Kentucky." The form listed above as *Tholocrinus* spec. is very closely related to, if not at least in part (see p. 2, footnote 1) identical with, *T. wetherbyi* (Wachsmuth and Springer), which is in turn merely Kirk's (1939, p. 471) new name for *Hydriocrinus wetherbyi*, listed by Ulrich under No. 41. *Linoproductus ovatus* does not appear in Ulrich's list, but *Productus pileiformis* does, which is, according to S. Weller, a synonym of the former. *Composita trinuclea* is another form not explicitly listed by Ulrich, but according to S. Weller

(1920, p. 375) it might well be hidden under his *C. subquadrata*.

Furthermore, Ulrich's "*Spirorbis* sp." may well be considered the equivalent of my *Spirorbis annulatus* Hall?, as may his "*Phillipsia* sp." be that of *Kaskia chesterensis* and, perhaps, his "*Anisotrypa* n. sp." that of my *A.*? spec.

Six more of the names listed above but not found in Ulrich's list can be disposed of thanks to the fact that they are recorded elsewhere from the Glen Dean. *Pentremites okawensis*, a species established only after 1917 by S. Weller (1920, p. 358) on a form occurring in the Glen Dean as well as in the Golconda, is recorded also by Butts (1926, p. 198) from the Glen Dean horizon (see also J. M. Weller, 1931, p. 286). *Zeacrinites wortheni* is stated by Springer (1926, p. 82) to be a crinoid "from the . . . Glen Dean of Kentucky and Okaw of Illinois." *Archimedes lativolvis* Ulrich (1905) is, according to McFarlan (1942, p. 441), "rather common in and characteristic of the Golconda," but it "has also been recognized, though it is not common, in the Paint Creek and the Glen Dean." *Orthotetes kaskaskiensis* appears in S. Weller's (1920, p. 196) faunal list of the Glen Dean, though not in Ulrich's. *Composita trinuclea*—even should it not be covered by Ulrich's listing of *C. subquadrata* (see p. 7 and above)—occurs, anyway, according to S. Weller (1920, p. 361), "in abundance in the Golconda and Glen Dean faunas in Hardin County and elsewhere, wherever these formations are well exposed." Finally, *Caneyella wapanuckensis*, to which the only pelecypod from Crane appears to be closely comparable, is recorded not only by Girty (1909, p. 35) from the Caney shale of Oklahoma, but also by Butts (1926, p. 200) from the Floyd shale of Alabama which is correlated by him (*ibid.*, p. 204) with "either Gasper or lower Bangor (Glen Dean)."

Thus, of all our forms seemingly or really missing in Ulrich's list there remain only three that to the best of my knowledge have not yet been explicitly recorded from the Glen Dean formation. The stratigraphic range of two of them, *Stenopora cestriensis* Ulrich and *Composita laevis* S.

Weller, is given by their authors (Ulrich, 1890, p. 442; S. Weller, 1914, p. 492) as "Chester group" without any more precise indication of the horizon. The same holds true of *Archimedes meekanoides* McFarlan, as far as Condra and Elias (1944, p. 126) are concerned. McFarlan himself (1942, p. 442), however, states his species to be "common in the Renault and Paint Creek formations," but it is certainly not surprising to find a Chester *Archimedes* one or, as in the present case, even two (limestone) formations above those of its greatest abundance.

Thus the paleontological evidence, as documented by the above faunal list, fully confirms the assignment of the fossiliferous limestones of Crane to the Glen Dean formation. This result is still corroborated by the fact that these limestones are conformably overlain by a plant-bearing sandstone which cannot be anything else than Tar Springs sandstone, the earliest Pennsylvanian being separated throughout that region by a "marked unconformity" from the Chester (J. M. Weller, 1931, p. 266; McFarlan, 1943, p. 96).

The agreement with the Glen Dean faunas of adjacent areas is, however, not nearly so perfect with respect to the most common forms which might serve as index fossils. Of the forms marked "o" in the above list only *Pentremites lyoni* and *Eridopora macrostoma* are granted "a high practical value as guide fossils" by Ulrich (1917, pp. 224, 226, 227), and *Pentremites spicatus* is recognized as characteristic of the Glen Dean formation by S. Weller (1920, p. 197) and J. M. Weller (1931, p. 263). On the other hand, *Prismopora serrulata*, not included in his "starred" forms by Ulrich (1917, pp. 224–225) merely because it is found also, though rarely, in the Gasper limestone, called the most important index fossil of the Glen Dean limestone by S. Weller (1920, p. 196), J. M. Weller (1931, p. 263), and Butts (1926, p. 200), and stated to be particularly useful also by McFarlan (1943, pp. 30–31), is rather poorly represented (by about half a dozen specimens) in the Crane area. There is no trace to be found of the "*Prismopora gardens*" emphasized by S. Weller (pp. 197, 374).

Even much rarer in the fauna here dealt with is *Archimedes laxus*, considered another characteristic Glen Dean fossil by all the authors quoted above. A single short fragment from Crane may be referable to this species. Another bryozoan, considered by McFarlan (1943, p. 91) "the most consistent and at the same time [an] abundant" Glen Dean fossil, *Cheilotrypa hispida* Ulrich, is entirely missing at Crane, as are the crinoids distinguished by their wing plates, *Pterotocrinus bifurcatus* and

P. acutus, both granted index fossil rank by Ulrich (1917, p. 227) and J. M. Weller (1931, p. 263) and the former by S. Weller (1920, p. 197) also.

An attempt to investigate how far these differences in the abundance of certain guide fossils are due to variations in ecological conditions, as expressed in facies differences between various exposures of the Glen Dean formation, might well be worth while.

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A NEW *SPHAERODACTYLUS* FROM THE DOMINICAN REPUBLIC

BY RUDOLPH RUIBAL

In 1935, Mr. William G. Hassler made a large and varied collection of reptiles in Hispaniola. It proved to include, when identification was undertaken a few years ago, a number of valuable specimens representing species that were new to the American Museum collection. Among the geckos of the genus *Sphaerodactylus* from Santo Domingo were two unidentified specimens which appear to belong to a species hitherto unknown.

The opportunity to describe representatives of the new form was made possible by Mr. Charles M. Bogert of the American Museum of Natural History. Dr. Doris M. Cochran, of the United States National Museum, whose published studies of Hispaniolan reptiles have been of much help in the preparation of this description, provided much needed assistance in making comparisons, and I take pleasure in naming the lizard in her honor.

Sphaerodactylus cochranae, new species

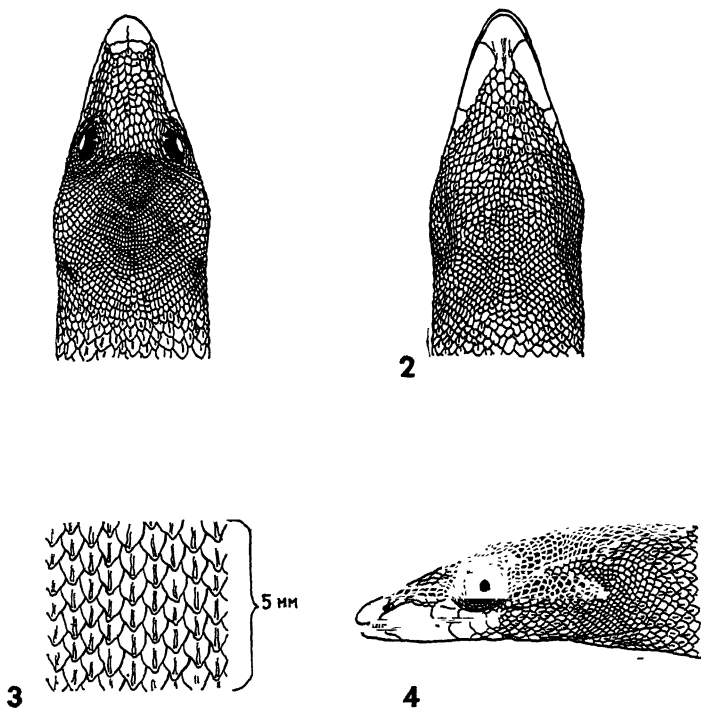
TYPE: No. 50233 in the collection of the American Museum of Natural History, collected by William G. Hassler at San Lorenzo Bay, on the south side of Samana Bay, in the Dominican Republic. In his field notes Mr. Hassler has the following concerning the specimen: "One longitudinally striped *Sphaerodactylus* from breakwater . . . July 24, 1935."

DIAGNOSIS: A medium-sized (28 mm., snout to vent) *Sphaerodactylus* related to *S. macrolepis*, but differing from it in three major respects: in having relatively larger dorsal scales, longer snout, and three distinct longitudinal stripes.

DESCRIPTION: An adult with a partially regenerated tail. Head relatively narrow, and elongate. The distance from the center of the eye to the tip of the snout is one-

seventh of the distance from the snout to vent. The distance from the center of the eye to the ear opening is 1 mm. less than the distance from the center of the eye to the tip of the snout. (Length of snout about 2.5 times the diameter of the eye.) The rostral is large with a median groove; two large supranasals are in contact directly behind this median groove. Scales on the snout moderately large (measuring, longitudinally, four scales to 1 mm.), non-imbricate but slightly keeled; scales on top of head and sides smaller (measuring longitudinally, six to eight to 1 mm.), and tuberculate, some with faint keels. A superciliary spine is present. The dorsal scales (that is, those with keels) are disposed in approximately 26 rows at mid-body, large, imbricate, and about five of them are equal to the distance from the center of the eye to the tip of the snout. No granular middorsal zone is present. The nostril is pierced in a scale situated between the rostral, the first labial, and the supranasal. There are four upper and four lower labials, the posterior one in each series small (see fig. 2). The mental is large and elongate, probably abnormally fused with the first two posterior scales; the region directly behind the mental is covered with enlarged scales, lightly keeled; posteriorly on the chin the scales become smaller, and all are smooth. The scales in the gular region are moderately large, and are smooth only at the center in an area about five scales wide. The scales of the chest and belly are large, imbricate, and smooth, the belly scales being larger than those of the chest. Six belly scales longitudinally are equal to the distance from the center of the eye to the tip of the snout.

The scales on the anterior surface of the forelimbs are like those of the belly; on



Figs. 1, 2, and 4. Dorsal, ventral, and lateral views of head ($\times 4$) of the type specimen.
Fig. 3. Dorsal scales of the type specimen.

the posterior and ventral surfaces of the forelimbs they are granular and much smaller. On the hind limbs, anteriorly and ventrally, the scales are like those on the belly scales but posteriorly they are granular and smaller. There are 13 smooth lamellae under the fourth toe, plus the enlarged distal scale.

The original part of the tail has keeled scales similar to the dorsal scales, but smaller; ventrally there is a single series of large, smooth scales that extend the length of the original tail, bordered on each side by three rows of smaller, smooth scales. On the regenerated portion there are broader, flatter, median scales.

DIMENSIONS: Snout to vent, 28 mm.; tail, 22 mm., of which the distal 13.2 mm. is regenerated; width of head, 4.6 mm.; center of eye to tip of snout, 4.0 mm.; tip of snout to ear, 7.3 mm.; foreleg, 7 mm.; hind leg, 9 mm.

COLORATION: (In alcohol.) A middorsal stripe extending from the frontal region to

the base of the tail varies in width but at mid-body embraces three scale rows. It is flanked on either side by a light stripe approximately two scales wide at mid-body. Dorsolateral blackish stripes extend from the nostril, through the eye, broadening above the ear opening, and continuing onto the sides of the tail. At mid-body the dorsolateral stripes fall on the ninth and tenth row of keeled scales. Ventrally the lizard is immaculate, although scattered melanophores are present on the lighter areas on the dorsum.

The legs are mottled with brownish, the hind legs having a light-colored spot on the femur and the knee. Due to the preservative, however, these markings may have faded. Mr. Hassler in his field notes described the fresh specimen as having "longitudinal black stripes on a pale tan or yellowish brown ground color; hind legs with slightly reddish spots; belly white."

PARATYPE: The only other representative of this species known to be available

is A.M.N.H. No. 50133. The single paratype measuring 29 mm. from snout to vent was collected by William G. Hassler at San Lorenzo and in his field notes he states: "July 22, 1935 . . . from a wall of limestone near caves." The paratype is mutilated, and differs in minor respects from the type. In the paratype the supranasals are separated by a smaller scale directly behind the median groove of the

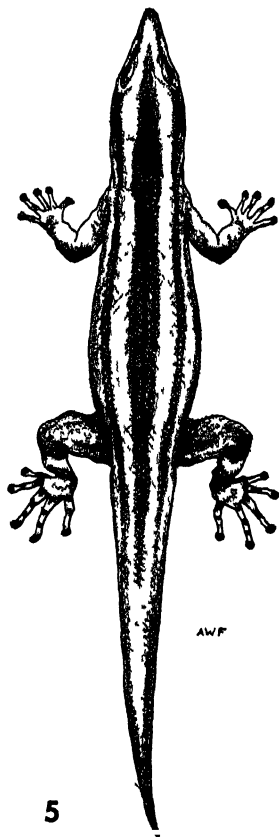


Fig. 5. Dorsal view of type specimen ($\times 2$) showing color pattern.

rostral. In addition to this the paratype has slightly smaller dorsal and ventral scales, the standard distance being equal to almost six dorsal scales and to about seven ventral scales.

RELATIONSHIPS: The new species appears to be more closely related to *Sphaerodactylus macrolepis* of Puerto Rico, and to

S. samanensis of Hispaniola. *S. samanensis* represents the only Hispaniolan *Sphaerodactylus* that has large, keeled scales that are in any way comparable to those of *S. cochranæ*. Though the new species has larger dorsal scales than *samanensis*, the heavy keels and general shape of the scales show a marked similarity in the two species. *S. copei*, the only Hispaniolan species having scales as large as those of *cochranæ*, is separable from it in having a granular middorsal zone. Moreover, the shape and keels of the scales in *copei* differ from those of the new species.

In coloring, *cochranæ* is not similar to any Hispaniolan *Sphaerodactylus*. The distinct stripes of the new species can be compared only to the longitudinal markings that are found in some specimens of *macrolepis*. In *macrolepis*, however, the stripes, when present, are not as in *cochranæ*, for they are brown instead of black in color, and instead of a single dark middorsal stripe there are a pair of paravertebral stripes.

The scalation of *macrolepis* and *cochranæ* suggests that the two are closely related. Most specimens of *macrolepis* examined have slightly smaller dorsal scales than those of the new species. However, a few specimens of *macrolepis* prove to have dorsal scales as large as those of *cochranæ*. (In the *macrolepis* having such large scales there were four dorsal scales to the standard distance.)

The large dorsal scales of *cochranæ* begin in the nuchal region. This feature of the scalation offers further evidence of a close relationship of *cochranæ* to *macrolepis*, for in the latter the large dorsal scales also begin upon the nuchal region, while in *samanensis* they commence at the shoulders.

Definitely separating *cochranæ* from *macrolepis*, aside from pattern differences, is the longer snout found in the new species. In *macrolepis* the standard distance (tip of snout to center of eye) is one-eighth the body length (tip of snout to vent), while in *cochranæ* the standard distance is one-seventh the body length. The measurements were made on 16 specimens of

macrolepis varying in size from 18.9 mm. to 31.3 mm. All showed the 1 to 8 ratio except the smallest specimen.

PARASITES: Three small mites of an unidentified species were present in the fold in the skin below the eye on the type.

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ADAPTIVE BRANCHING OF THE KANGAROO FAMILY IN RELATION TO HABITAT

By H. C. RAVEN¹ AND WILLIAM K. GREGORY

INTRODUCTION

The present report is a summary of the principal conclusions of a more detailed, unpublished work by H. C. Raven on the evolution of the kangaroos, containing a revision of the genera and species, both recent and fossil.

The modern classification of the Macropodidae and consequently the materials for the study of the evolution of the family are very largely embodied in Oldfield Thomas' well-known "Catalogue of the Marsupialia and Monotremata of the British Museum" (1888), supplemented by "The mammals of South Australia" by Frederic Wood Jones (pt. 2, 1924), and by Iredale and Troughton (1934). Although Thomas' excellent work does not use the word evolution and begins with the most advanced members of the family, working backward to the most primitive, a careful reading of the text shows that Oldfield Thomas had very definite and, as it seems to us, usually well-founded views concerning the interrelationships of the major divisions of the family. Dollo, following Huxley, was more interested in the major evolutionary features in the marsupials as a whole than in the detailed relationships of the included genera and species. Bensley (1903) in his well-known monograph gave excellent comparative figures of single upper and lower molars and premolars, as well as the soles of the foot in several species of kangaroos.

In 1921 the authors of the present report went together to Australia from the American Museum of Natural History in order to make personal contacts with fellow naturalists in the Australian museums, to gain

field experience and some first-hand knowledge of the habits of the marsupials, and especially to secure a representative collection of Australian marsupials both for exhibition and for our study collections. One of us (H. C. R.) remained in Australia for about two years for the purpose of collecting and studying the habits of these animals in the field. A series of specimens of various marsupials was also injected with preservatives in the field and brought home for comparative anatomical study. Thanks to the kind cooperation of various Australian naturalists, including the late Dr. Charles Anderson of the Australian Museum, Sydney, Mr. Heber Longman of the Queensland Museum, Brisbane, and Prof. Frederic Wood Jones, then of the University of Adelaide, a number of rare and interesting forms, together with considerable fossil material not represented in our own collections, were secured. We have also to thank Dr. Gerrit S. Miller, Jr., of the United States National Museum, and Dr. W. H. Osgood, of the Chicago Natural History Museum, for the loan of valuable specimens for comparison, while our own Department of Mammals, under the chairmanship of Dr. Harold E. Anthony, has been unstinting in its assistance. For the use of figures 6, 17, and 21 we are indebted to Dr. G. H. H. Tate of the Department of Mammals here, who photographed the skulls of these rare marsupials in the collection of the British Museum (Natural History) in 1937. After the untimely death of H. C. Raven, Dr. John Eric Hill, Assistant Curator of the Department of Mammals, rendered invaluable assistance in the final stages of the work. (W.K.G.)

¹ Died April 5, 1944.

It might perhaps be deemed strange and it is certainly unusual to plan a work professing to deal primarily with the evolution of a family of recent mammals instead of the conventional catalogue of the collections secured. But we are convinced that in the case of the marsupials there is a greater need of more studies on evolution where the emphasis is laid upon the structural relationships and genetic affinities rather than solely upon the systematic differences. For the differences between the species and genera of kangaroos have been most thoroughly and judiciously treated by Oldfield Thomas and his successors and are already a matter of record.

We have also examined the literature and specimens of the numerous Pleistocene kangaroos with the view of determining, if possible, their connections with the recent genera.

The kangaroos appear to be a singularly favorable group for the study of evolution for the reason that a relatively large number of "living fossils" plainly perpetuate the chief stages, from the tiny and generalized musk kangaroo (*Hypsiprymnodon*), which, as shown by Oldfield Thomas and Dollo, represents an early stage following the descent of the ancestral phalangerid from the trees, to such specialized giants as the Pleistocene *Palorchestes*.

ADAPTIVE BRANCHING IN RELATION TO HABITAT

In order to collect small mammals successfully, one must naturally know where to set traps and with what sorts of food to bait them. Examination of stomach contents and later of the dried skull and dentition brings out clearly the relations between structure, habits, and habitat without, however, either confirming or disproving the classical saying that changes in habit precede changes in structure. In the case of the kangaroos the ancestral habitat is doubtless the rain forest, and the ancestral foods are leaves, seeds, berries, fruit, and roots lying on or near the ground, together with insects, grubs, and worms. Of this ancestral stage only the tiny musk kangaroo of north Queensland remains as a living witness. But the forest leads out into the gullies and thickets, and here we find the typical rat kangaroos (*Bettongia*) which with their short muzzles and strong jaws tear at the tough woody roots and wear down their teeth, as do bandicoots.

And in other directions the rain forest leads into the open forest, where beneath the thin silvery shade of the eucalypts fine grass grows. From here to the open plains the grass-eating wallabies and kangaroos are met in most abundance, while in the border zone the larger wallabies hide in the forest by day and move out to feed on the grassy plains at night. Some of the Pleistocene kangaroos (the *Sthenurinae*), acquiring massive jaws and thickly wrinkled molars, may have fed upon the coarser shrubs of the forest. Thus there seem to be discernible relations between the classification and evolution of the kangaroos and their several habitats, which are expressed in the phylogenetic diagram (fig. 1).

We may then proceed to outline our present understanding of the evolution of the group under the subfamilies as recognized by Thomas, with the addition of the Pleistocene *Sthenurinae*.

TABLE 1
PRINCIPAL CHARACTERS OF THE SUBFAMILIES

	Nature of Habitat	Canine	I ³ Notch	Post. Upper Premolar	Man- dibular Sym- physis	Upper Molar Crowns
Hypsiprymnodontinae	Forest	×	0	Diagonally placed, many grooves	Loose	Quadrilater- ular
Potoroinae	Thicket	×	0	Elongate, straight, trenchant, grooved	Loose	Quadrilater- ular
Sthenurinae (<i>Sthenurus</i> , <i>Palorchestes</i>)	Forest and grass- land	0	0	Roundly triangular crown, grooves reduced, inner lobe complete, no secant edge, no grooves	Anky- losed	Bilophodont
Macropodinae Brachyodont Section <i>Dorcopsis</i> , <i>Dendrolagus</i>	Forest	×	0	Elongate with se- cant edge, with grooves, postero- internal lobe complete	Loose	Bilophodont
<i>Thylagale</i> , <i>Setonix</i>	Forest	0	×	Same as above	Loose	Bilophodont
Hypsodont Section <i>Lagostrophus</i> , <i>Lagor- chestes</i> , <i>Protemnodon</i> , <i>Peradorcas</i> , <i>Petro- gale</i> , <i>Onychogalea</i> , <i>Macropus</i>	Grass- land	× 0	× 0	Size variable, crown compressed, pos- tero-internal lobe present	Loose	Bilophodont

THE MUSK KANGAROOS (HYPSSIPRYMNODONTINAE)

According to Pierson Ramsay, the describer of *Hypsiprymnodon moschatus* (cited by Oldfield Thomas, 1888, p. 124), this "highly interesting and anomalous marsupial inhabits the dense and damp portions of the scrubs [rain forest] . . . Its habits are chiefly diurnal . . . it progresses in much the same manner as the kangaroo rats (*Hypsiprymnus*), to which it is closely allied, but procures its food by turning over the débris in the scrubs in search of insects, worms, and tuberous roots, frequently eating the palm berries (*Ptychosperma alexandrae*), which it holds in its forepaws after the manner of the phalangiers, sitting up on its haunches, or sometimes digging like the bandicoots. . ."

As noted by Oldfield Thomas and later authors, this little kangaroo links the

Macropodidae with the older Phalangeridae, first, because its hind foot retains the hallux and the digital pads, while the second and third digits are strongly syndactylous.

Its dentition also has advanced but little toward the kangaroo type (fig. 4). Thus its posterior upper premolars inherit the prominent, vertically high and compressed crowns, with the cutting edge and prominent vertical grooves, which are characteristic of the phalangiers. Likewise these opposite secant premolars are directed sharply outward as in the phalangiers, while in the mandible the secant premolars could be derived in a general way from the type illustrated by the Pleistocene phalanger *Burramys* of Broom (1896), which it also somewhat resembles in its

TABLE 1 (continued)

Longitudinal Connecting Ridges Be- tween Loph- s of Upper Molars	Relative Lengths (ap.) m^1 and m^4	Elevation of Mandibular Condyle Above Level of Tooth Row	Inclina- tion of Ant. Border Ascend- ing Ramus to Tooth Row	Ears	Tail: Head and Body Length ¹	Foot: Head and Body Length ¹
Absent	$m^1 > m^4$	Low	About 45°	Short	Medium (64-66%)	Medium to long (23-24%)
Absent	$m^1 > m^4$	Low	Slightly more	Moderate	Very short to medium (43-81%)	Short to very long (18-37%)
Present	$m^1 < m^4$	High	Steep	—	—	—
Present	$m^1 < m^4$	Intermediate	Less steep	Short to very short	Short (60%) to very long (111%) (<i>Dendrola- gus</i>)	Short to moder- ate (19-23%)
Present	$m^1 < m^4$	High	Nearly at right angle	Short	Very short (43-56%)	Very short (16-18%)
Present	$m^1 < m^4$	High	Nearly at right angle	Usually long (except in <i>Lagostro- phus</i> , <i>Lagor- chestes</i>)	Medium to long (62-100%)	Medium to long (21-29%)

very long procumbent lower incisors. It is even more primitive than *Burramys*, however, in retaining vestiges of the second lower incisors, which are minute teeth, the crowns of which rest largely on those of the enlarged first incisors. The small upper molars are remarkably primitive for a kangaroo in that they are brachyodont, virtually quadritubercular, and diminish in size from m^1 to m^4 as in certain phalangers; also the opposite tooth rows converge posteriorly instead of being more nearly parallel as in the kangaroos. All this is apparently reminiscent of a time when the secant premolars were the dominant teeth of the dentition, whereas in the typical kangaroos the premolars finally become

much reduced as the molars gain in size and importance.

The tail is slender in contrast with that of typical kangaroos. On the other hand, the little musk kangaroo is a true kangaroo in the hopping adaptations of its hind feet, a singularly constant character in the entire family. Also the two halves of its mandible are slightly movable at the symphysis, as in the kangaroos, due to the ligamentous connection there, while the general shape of the skull with its elongate muzzle and simple ungrooved upper incisors approaches that of *Potorous tridactylus* of the rat kangaroos. As in *Potorous tridactylus*, the "alisphenoid bullae" are relatively small and but little inflated.

¹ Percentages based mostly on measurements given by Oldfield Thomas (1888).

THE RAT KANGAROOS (POTOROINAE)

From such a type as *Hypsiprymnodon*, described above, the steps to *Potorous tridactylus* (fig. 5) are not many. The muzzle in this species, however, is even more elongate than that of *Hypsiprymnodon*, while its secant upper premolar (p^4 of Thomas) has become extremely elongated anteroposteriorly and lacks an inner basal cusp. In passing we may note that after comparing the skulls and teeth we can hardly agree with Bensley (1903, p. 143) in referring *Hypsiprymnodon* to the same subfamily with *Aepyprymnus*, while separating *Potorous* and *Caloprymnus*, apparently on the basis solely of the number of grooves on the fourth upper premolar, because the number of grooves on the outer side of this tooth varies in the different species of *Potorous* from four to two.

In all the Potoroinae (as defined by Thomas) the fourth premolars are the dominant cheek teeth in both the upper and lower jaws, in the sense that they are the most conspicuous single pair of teeth and that they stoutly maintain their place below the front end of the zygomatic arch instead of being pushed forward by the oncoming molars, as they are in the typical kangaroos. These forms, all living in thickets, evidently give their teeth very hard usage, grinding them down on the tough woody tissue of roots mixed with more or less sand, grass, and seeds. The molars, quadritubercular in *Potorous* and *Bettongia*, become almost bilophodont in *Aepyprymnus*. While, as noted above, the muzzle of *Potorous tridactylus* is elongate, that of *P. platyops* is markedly shorter and could give rise to the still shorter face of *Bettongia* and *Aepyprymnus*. The auditory bullae are small in *Potorous*

tridactylus in spite of its small body size, but they become very large and inflated in *Bettongia lesueuri*, possibly indicating life in more open country.

The hind feet, rather primitively short in *Potorous* and retaining the primitive friction pads, are long and slender in *Bettongia* and *Aepyprymnus*. All lack the hallux. The fore claws are large and are used for digging. Of these genera *Potorous* is the most primitive in retaining the friction pads on the pes, the elongate muzzle, narrow cranium, low mandibular condyle, very oblique coronoid process, markedly procumbent slender lower incisors, slender malar with small masseteric tubercle, slight inflation of auditory bulla. All these habitus features go with its forest habitat and its heritage from *Hypsiprymnodon*. *Caloprymnus* (fig. 6) is highly specialized in its extremely wide short muzzle, wide cranium, reduced grooves on its premolars, and relatively very long hind feet. These features go with its semi-arid habitat in South Australia.

Of the remaining genera, *Bettongia* (fig. 7) inherits from *Hypsiprymnodon* the narrow grooves on its secant premolars, as well as most features of its dentition. The bullae range from medium to very large. A picture by Harry Burrell (Le Souef and Burrell, 1926, fig. 54, p. 235) shows *Bettongia* using its tail in a prehensile way to carry nesting material—a heritage of its arboreal phalangerine ancestry. *Aepyprymnus* (fig. 8) has developed a heavier dentition throughout, with shorter face, very short diastema, more heavily braced skull. *Bettongia* and *Aepyprymnus* live in grass country, hiding in thickets.

THE HEAVY-JAWED PLEISTOCENE KANGAROOS (STHENURINAE)

The Pleistocene *Sthenurus* (fig. 9) has a remarkably robust, wide, short, and deep skull, with extremely short face, massive jaws ankylosed at the symphysis, great vertically deep zygomatic arches with long downwardly produced masseteric malar processes on the anterior ends of the malars; the posterior lower premolars (fig. 1) are

short, bunodont, with prominent postero-external swelling and double longitudinal crest, with four or more grooves on the lingual side. The primitive crest points obliquely outward in unworn teeth. The upper premolars when unworn approach a tricuspid type, which could be derived from a *Dendrolagus*-like form through

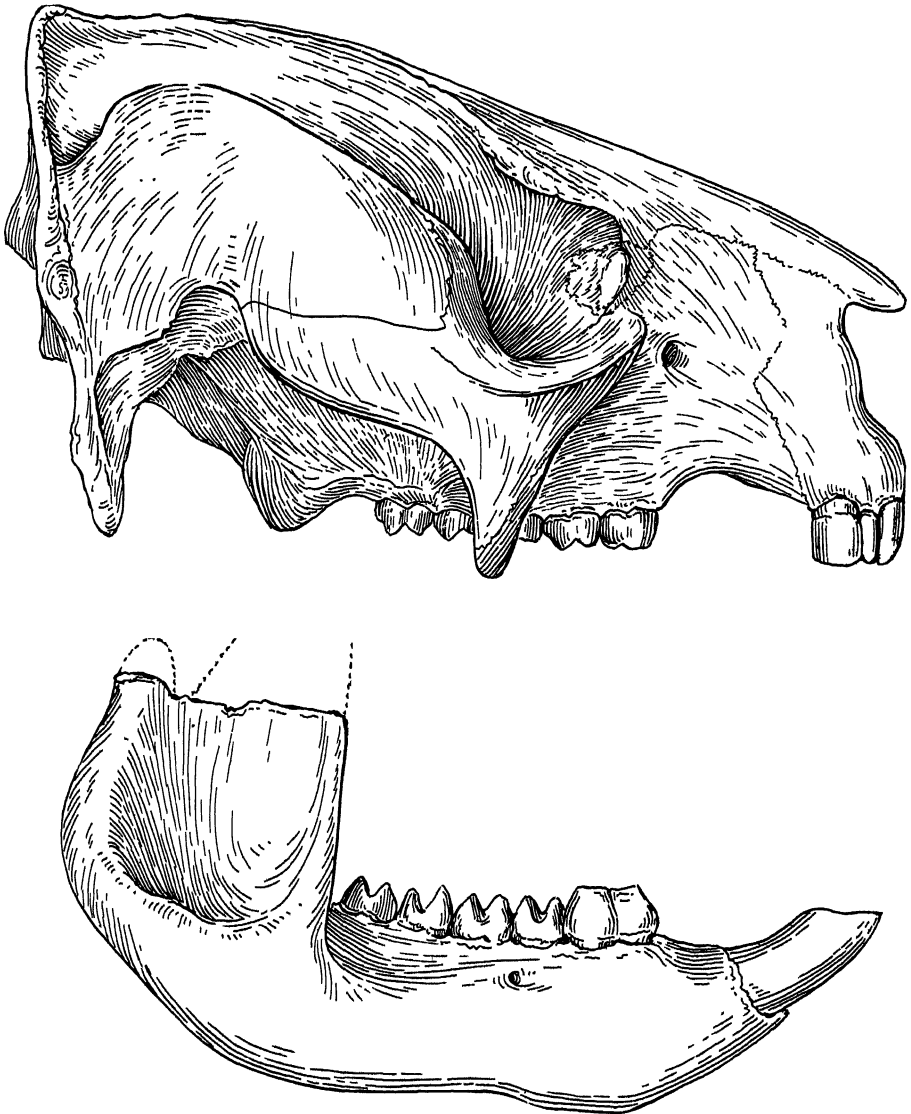


Fig. 2. *Sthenurus occidentalis* Glauert. Skull and lower jaw from model by Glauert and photographs of the type. $\times \frac{2}{3}$.

marked anteroposterior shortening, which is evident in all other parts of the skull. The molars are massive, with thick longitudinal connecting crests and many prominent grooves and plications, in wide contrast to the smooth, sharp ridges of typical kangaroos.

Possibly the Sthenurinae may be survivors of the more primitive forms that

gave rise to the tree kangaroos, from which, however, they differ in the characters of their premolars, but on the whole it seems easier to derive the *Sthenurus* premolars from a forerunner of the *Dendrolagus* type than from those of either the typical *Macropus* or the *Hypsiprymnodontinae* and *Potoroinae*. The genus *Sthenurus* includes six or more species described

by Owen (1839, 1873, 1874), De Vis (1896), and Glauert (1910), all of the stout-jawed type.

The Pleistocene *Palorchestes* (including two species described by Owen, 1873, 1874a, and one by De Vis, 1896) belonging to this subfamily had a skull 16 inches in length, which was proportioned more as in normal kangaroos (fig. 10). Its premolars

and mandible, however, are related to those of *Sthenurus* (figs. 2, 9). It may be, therefore, that we are dealing with dolichocephalic and brachycephalic related genera within the same subfamily, as in certain groups of ungulates, and as in the genera *Potorous* and *Dorcopsis*, each of which has a dolichocephalic and a brachycephalic species.

THE WALLABIES, TREE KANGAROOS, AND KANGAROOS (MACROPODINAE)

Passing to the Macropodinae, or true kangaroos (*Macropus*), wallabies (*Protemnodon*), pademelons (*Thylogale*), and allied forms, we enter a group containing the majority of the species of the family and ranging from the tiny banded wallaby (*Lagostrophus*) to the gigantic *Macropus titan* of the Pleistocene and including even the highly specialized tree kangaroo (*Dendrolagus*). The brachyodont members of this subfamily (*Dorcopsis*, *Dendrolagus*, and *Thylogale*) are predominantly forest-living forms, some of which extend their range into more open country, but the majority, including the hypsodont section (cf. table 1), inhabit the grasslands and even invade the areas cleared by man.

The most conspicuous evolutionary tendency in the dentition is the assumption of sharply bilophodont and progressively hypsodont molars, which adapt these animals to the grasslands, together with the gradual reduction of p_4^* in size and functional importance, culminating in their complete elimination in old individuals of certain species of *Macropus*. With the pushing out of the p_4^* at the front end of the tooth row, the molars gradually move forward in the jaw and in turn fall out in front, so that in extremely old, great gray kangaroos only the fourth molar may be retained, but in a marked forward position in the jaw.

The third upper incisors develop a postero-external groove, which appears in an incipient stage (fig. 3, A) in *Thylogale*, reaches its climax in the large wallabies (*Protemnodon*), where it has shifted to the middle of the labial surface and then passes forward to near the front end of the labial face in some of the large kangaroos

(fig. 3, C). This groove wears off with age and may disappear entirely in very old skulls.

Dorcopsis (*sensu lato*), inhabiting the forests of New Guinea, includes small wallabies with a very long secant p_4^* with conspicuous internal cusp. The p_4^* is relatively larger than in the higher kangaroos. The molars are brachyodont; the upper canines, although small, are present. The tail and ears are relatively short; the feet are of moderate length.

The genus *Dorcopsis* Schlegel and Müller, 1842 (type, *Didelphys brunii* Schreber, 1777) includes many species. Matschie (1916) divides the group into two genera, *Dorcopsis* (fig. 11) and *Dorcopsulus* (type, *D. macleayi*, our fig. 12), the latter being small with a short muzzle, less elongate "secator" (compressed upper premolar), and more extended and abrupt nakedness of the tail. Some of the species of *Dorcopsulus*, which vary in minor characters, may almost include the survivors of the ancestral stock leading to *Thylogale* and the higher kangaroos, while *Dorcopsis* (*sensu stricto*) is a specialized dolichocephalic side branch (fig. 11).

One species (*D. macleayi*), according to Thomas (1888, p. 92), is in many ways intermediate between "*Dorcopsis*" (= *Dorcopsulus*) and "*Macropus*" (= *Thylogale*) *brownii*, while the type *D. brunii* bears a strong superficial resemblance to "*Macropus brunii*" of Aru (Thomas, 1888, p. 89). In the other direction, Garrod (1875) and Thomas (1888, p. 87) have pointed out that *Dorcopsis* (= *Dorcopsulus*) is connected with the tree kangaroo, *Dendrolagus*. Bensley (1903, pp. 153, 178, 201) even concluded that *Dorcopsis* was derived from *Dendrolagus*, but we think that the

evidence can be better interpreted in the opposite way.

Dendrolagus (fig. 13) inhabits the rain forests of New Guinea and north Australia, browsing in the trees and on the ground; when climbing, the powerful arms are used in alternation with the broad-soled hind feet, which move in unison and thus retain the typical kangaroo type of locomotion.

In spite of the marked superficial difference in appearance from normal kangaroos, it would be quite unjustifiable to separate the tree kangaroos as a distinct subfamily, because, as noted above, they are closely related to *Dorcopsulus*. In its dentition *Dendrolagus* closely resembles that genus, though its p^4 is somewhat less secant. The skull is broader in the facial region. The most significant difference is to be found in the arboreal adaptations of *Dendrolagus*, namely, its comparatively broad short pes with wide plantar pad, proportionately heavy fore limbs, and strong curved claws. Its tail is long, slender, and evenly haired above and below, and its ears are shorter than in any other member of the family. Here again *Dorcopsulus* seems to be in every way closely related to *Dendrolagus* and an ideal structural ancestor for it, as well as for the higher kangaroos.

The closure of the palatine fenestrae in several species of widely separated genera of macropods, such as *Aepyprymnus*, *Dendrolagus*, *Palorchestes*, and *Macropus*, is considered to be purely secondary.

The three species of hare wallabies, *Lagorchestes*, inhabit dry country from the interior of New South Wales to islands off the northwest coast. This genus has advanced far beyond the Potoroinae in its more bilophodont molars and its more abruptly constricted face as seen from above (see fig. 14). Also its fourth upper premolar is smaller than that of the Potoroinae and has a pronounced anterior cusp and strong internal cingulum with a basal cusp at the postero-internal end. A strongly developed process of the maxilla juts down from the lower border of the zygomatic arch as in typical kangaroos. The groove on the labial surface of the upper third incisor is pronounced and well

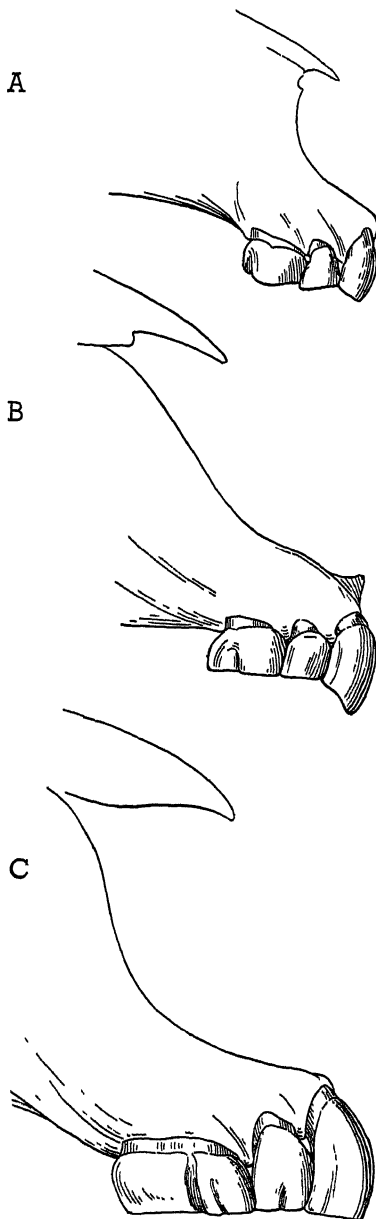


Fig. 3. Outlines of upper incisors: A, *Thylogale*; B, *Proteomnodon*; C, *Macropus*. $\times 1\frac{1}{2}$.

forward in position. On the other hand, in common with the Potoroinae, *Lagorchestes* retains the upper canines (although small). The body is small and the head

deep and broad, the muzzle short; the tail and foot are comparatively long. It may have been derived as a dwarf from the stem of the typical wallabies (*Protemnodon*), which has secondarily sought the cover of thickets.

Lagostrophus, the banded wallaby of Western Australia and some of the islands of Sharks Bay, Western Australia, is a diminutive kangaroo with a very narrow short muzzle and fairly wide skull; it has lost the upper canine (fig. 15). In conjunction with its compressed muzzle, the second and third incisors are nearly parallel with those of the opposite side. In most respects it is a typical kangaroo, although living in thickets, to which it is adapted by its small size. Its nearest living relatives are *Thylogale* and *Petrogale*. Like *Lagorchestes* it may have been derived from the hypsodont, grass-living stem of the higher kangaroos, which has secondarily invaded the thickets.

Thylogale,¹ the pademelon wallabies (fig. 16), are a compact group of about nine species, all small brachyodont wallabies with short tails, short feet and ears, and a groove near the posterior margin of the third upper incisor; the nasals are very broad posteriorly. They inhabit the forest from New Guinea and the New Britain group of islands to Tasmania. They are not found far from the coast of Australia. The upper premolar retains its position even in old skulls, and in general these are primitive forerunners of the larger wallabies and true kangaroos of the grasslands.

Setonix of southwestern Australia, as noted by Oldfield Thomas (1888, p. 62), convergently resembles externally the rat kangaroos (*Potorous gilberti* and *P. platyops*) of the same region, but its nearest relatives belong to the genus *Thylogale*. It resembles *Thylogale stigmatica* in having a peculiar upward central projection of the top of the rhinarium (fig. 17). Its secant premolar is greatly elongated with many

grooves (another convergence toward the Potoroinae), and its skull is broadly and strongly built with enlarged zygomatic arches, all indicating coarse tough food. Its third upper incisor differs from that of *Thylogale* in being very small, its notch about at the center instead of at the back (Oldfield Thomas, 1888, p. 61).

Protemnodon (fig. 18) contains mainly the "large wallabies" of Thomas, but includes certain forms (*eugenii*, *bedfordi*, and *parma*, and perhaps one or two others) which Thomas referred to his group of "small wallabies." The *protemnodons* are widely distributed over the whole of Australia and Tasmania and even reach New Guinea. We also include here a number of Pleistocene forms, mainly described by Owen, Lydekker, and De Vis, some of which were larger than the largest living kangaroo (see below).

In most of the recent large wallabies the secant p_4 is somewhat less conspicuous than in the type of "*Macropus*" *anak* Owen but is always retained throughout life. The muzzle is shorter than in *Macropus*. The molar teeth are not so brachyodont as in *Thylogale* but are less hypsodont than in typical *Macropus*. The third upper incisor has usually a well-developed groove about the middle of the labial surface. Palatal vacuities are conspicuous.

The ears are larger than in *Thylogale*, the feet are longer, and the tail is longer and tapering.

These forms all feed on the grassland, though some of them spend the day hiding in the forest or thickets. In general their color is not so dark as it is in the forest-living forms. A cheek stripe and a hip stripe are frequently present. The most conspicuous feature of the fossil *protemnodons* was the elongated, highly secant p_4 in the lower jaw, to which the name refers.

The connections between the recent large and small wallabies and the Pleistocene forms were badly confused in the nomenclature. Thomas (1888) divided the genus *Macropus* into three groups, using size as his principal criterion: first, *Macropus (sensu stricto)*, including only the largest living kangaroos (*M. giganteus*,

¹ We are accepting Oldfield Thomas's designation (1888, p. 10) of the type of *Thylogale* Gray as *Macropus thetidis* [sic] Lesson (1827, p. 129). We regard *Thylogale eugenii* (Desmarest, 1817),¹ Wood Jones (1924, p. 235) as an aberrant member of the *Protemnodon* group (see p. 11).

antelopinus, *robustus*, *isabellinus*, *rufus*, *magnus*); second, the "large wallabies" (*M. ualabatus*, *ruficollis*, *greyi*, *dorsalis*, *parryi*, *irma*, *agilis*); third, the "small wallabies" (*M. coxeni*, *stigmaticus*, *wilcoxi*, *brunii*, *browni*, *thetidis*, *eugenii*, *parma*, *billardieri*, *brachyurus*). Since 1888 a number of forms have been added to each of these groups. As noted above, *eugenii*, *parma*, and *bedfordi* are here included with the "large wallabies" named above in *Protemnodon*, for the following reasons:

1. The type of *Protemnodon* Owen is the Pleistocene form *Macropus anak* Owen, based on "a portion of a left mandibular ramus, including the molar series . . .," which was figured by him in his memoir of 1874 (pl. 25, figs. 1, 2). This was a very good type, and it compares closely in almost every feature, except its greater size, with the corresponding parts of a modern wallaby, such as *Protemnodon bicolor* or *P. agilis* (fig. 18).

2. He later referred to the same species several maxillary tooth rows which were shown by Lydekker (1887) to belong to different genera. Nevertheless this did not invalidate the use of the name *Protemnodon* for members of the genus to which the type of *Protemnodon anak* belonged.

3. *Wallabia* Trouessart, 1905, which was chosen by Iredale and Troughton (1934, p. 47) as the generic name of this group, is clearly antedated by *Protemnodon* Owen.

4. De Vis (1896, p. 104) referred to "*Protemnodon anak* Owen (*partim*)" several other named Pleistocene forms but in turn grouped them all under *Halmaturus*, a synonym of *Macropus*.

Another difficult problem has been the proper limitation of the genus *Thylogale* Gray, 1837. Gray's definition of this subgenus of "*Halmaturus*" (*Macropus*) was: "The hinder fold of the hinder upper cutting tooth scarcely larger than the front one, so that the tooth appears only notched behind. Front incisor short, simple." The type and only species cited by Gray was *eugenii*, which Thomas (1888, p. 10) synonymized with *Macropus thetidis*, probably because Gray's definition applies perfectly to *thetidis* but not to *eugenii* in Thomas' sense (*op. cit.*, p. 54). The ex-

cellent descriptions and figures of "*Thylogale eugenii*" by Wood Jones (1924, pp. 235, 239) prove that he is dealing with a small member of *Protemnodon*, not *Thylogale*, as these terms are understood above. Apparently no true *Thylogale* exists in South Australia at the present time.

Onychogalea unguifer, the nail-tailed wallaby of the northwest coast of Australia, is virtually a small, specialized *Protemnodon* with a delicate dentition and slender limbs (see fig. 19). Its name refers to the possession of a "peculiar horny excrescence at the tip of the tail" (Thomas). The upper premolars are greatly reduced and bilobate. The skull is moderately broad and the muzzle compressed. The molars are hypsodont in accordance with its habitat of open dry country. The tail is very long in *O. unguifer* but only moderately long in *O. lunata*.

The rock wallabies, *Petrogale*, are widely distributed over the whole of Australia, but not Tasmania (Thomas, 1888, p. 62), in suitable localities where there are rocky hillsides and caves offering shelter. All the incisors are delicate, the third laterally spatulate with a slight groove on its lateral face. The muzzle is narrow, the skull moderately broad (see fig. 20). The foot is very long, narrow, with a short claw on the main digit. The tail is very long.

The single species of *Peradorcas*, *P. concinna* Gould, the little rock wallaby, is a remarkably specialized animal from the northwest coast of Australia (cf. fig. 21). "General characters as in *Petrogale* but the molars on each side increased in number, seven at least on each side and probably more, falling out in front and renewed behind as in the Manatee (*Trichechus*)"—a remarkable case of sudden departure from the ancestral type. The skull, as described by Thomas (1888, p. 71), is very small and quite different in shape from that of the other species of rock wallabies. Facial portion comparatively short and braincase large. Muzzle short, narrow, and pointed, not inflated. Nasals very narrow in front and enormously broadened behind. Both the tail and the foot are moderately long.

In the true kangaroo, *Macropus*, as

noted above (p. 8), the dentition reaches a new evolutionary plane, in which the reduced upper and lower fourth premolars lose their importance and are shoved out of the dentition shortly after the eruption of the fourth molar. The molars meanwhile have acquired a fore-and-aft sequence, the front ones being shed as the hinder ones push forward. In connection with the grazing habits the muzzle becomes elongated, producing a long, compressed, lingual channel in the mandible. The groove on the third upper incisor varies in the different species, as does the length

of the crown of this tooth (see fig. 22). As noted above, the true kangaroos are confined to the grassy regions of Australia and Tasmania. Some of the recent ones reach a standing height of 7 feet, which must have been greatly exceeded by some of the Pleistocene species of *Protemnodon*.

The foot structure in the subfamily is remarkably uniform in essentials, but there is gradual lengthening of the foot from *Thylagale* to the great kangaroos.

The principal species of *Macropus* are listed above.

CONCLUSIONS

1. The general concept of the origin and evolution of the kangaroos from small, arboreal, forest-living phalangers, as developed by Huxley, Dollo, and Bensley, seems entirely in harmony with the field and museum studies herein summarized. These new studies also strongly support the thorough taxonomic work of Oldfield Thomas.

2. Many "living fossils" still survive to indicate the several lines of adaptive branching, starting from the ancestral forest-living *Hypsiprymnodon*: in one direction leading into the thickets (Potorinae); in another direction from the forest out into the grasslands (*Thylagale*, *Protemnodon*, *Macropus*); in a third direction, probably derived from *Dorcopsulus* and ending up in the trees (*Dendrolagus*); a fourth line, including the thick-jawed giants (Sthenurinae) of the Pleisto-

cene, may have started not far from *Dorcopsulus*.

3. The true wallabies (*Protemnodon*) are here separated from the true kangaroos (*Macropus*) because of the persistence of their large fourth premolars. The evidence for their close relationship to the Pleistocene *Protemnodon* is set forth.

4. Notwithstanding the great differences between the primitive *Hypsiprymnodon* and such highly specialized genera as *Macropus*, *Dendrolagus*, and *Sthenurus*, the survival in the existing and Pleistocene faunas of so many living fossils, together with the failure of any of the kangaroos to spread from the New Guinea region into Malaysia, suggests a relatively late geological date (middle to late Tertiary) for the origin of the family from phalangers akin perhaps to the Pleistocene *Burramys*.

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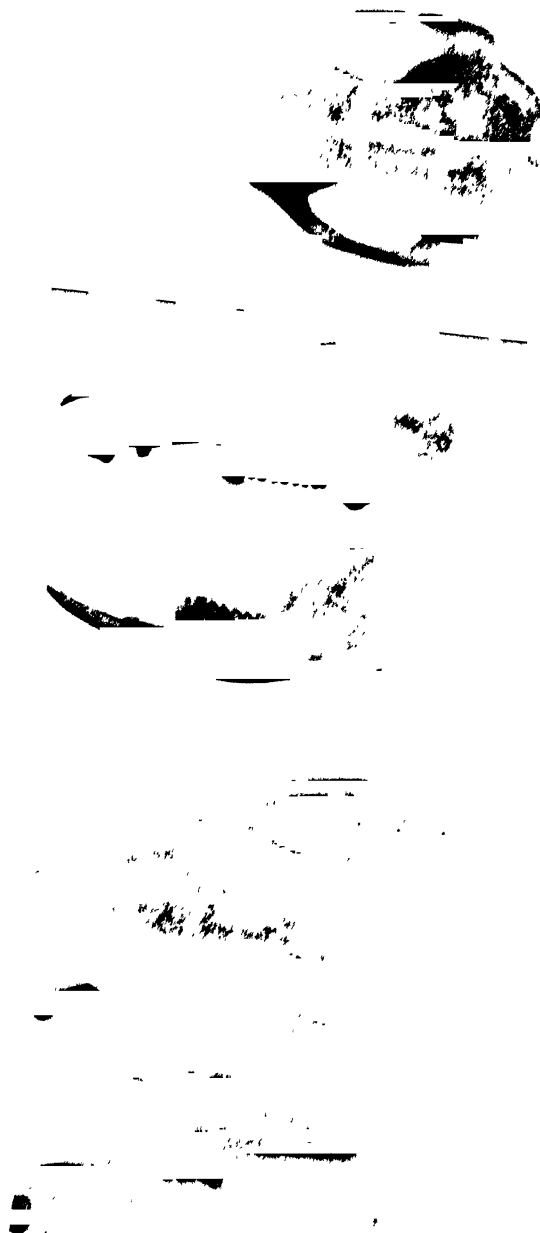


Fig 4 *Hypsiprymnodon moschatus* Ramsey USNM No 238445.

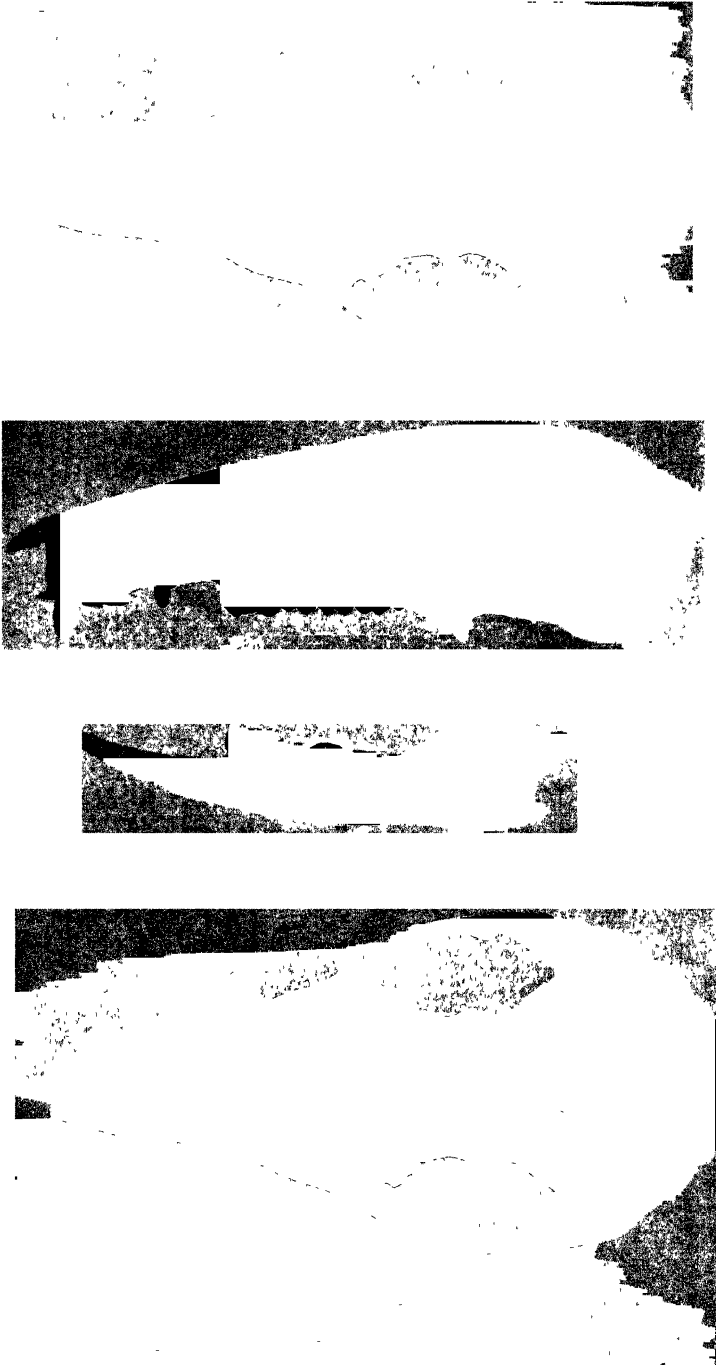


Fig. 5. *Pteropus bridgmanii* Koenig. A.M.N.H. No. 65328.

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ADAPTIVE BRANCHING OF KANGAROOS

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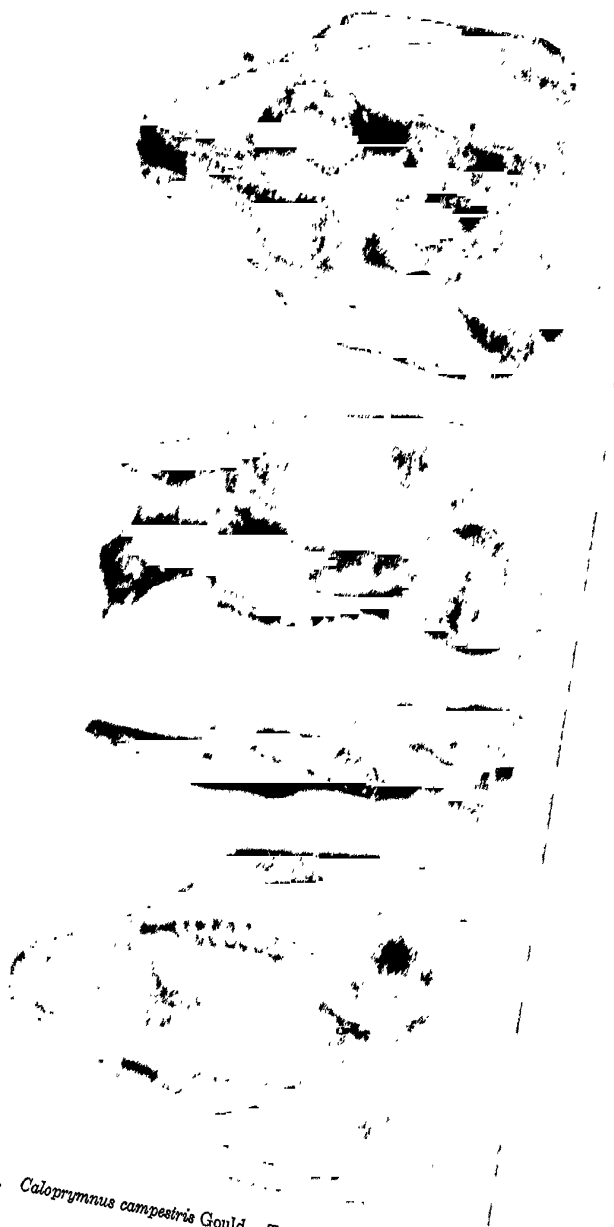


Fig 6. *Caloprymnus campestris* Gould. Type, B.M.N.H. No. 46.4.4.44.

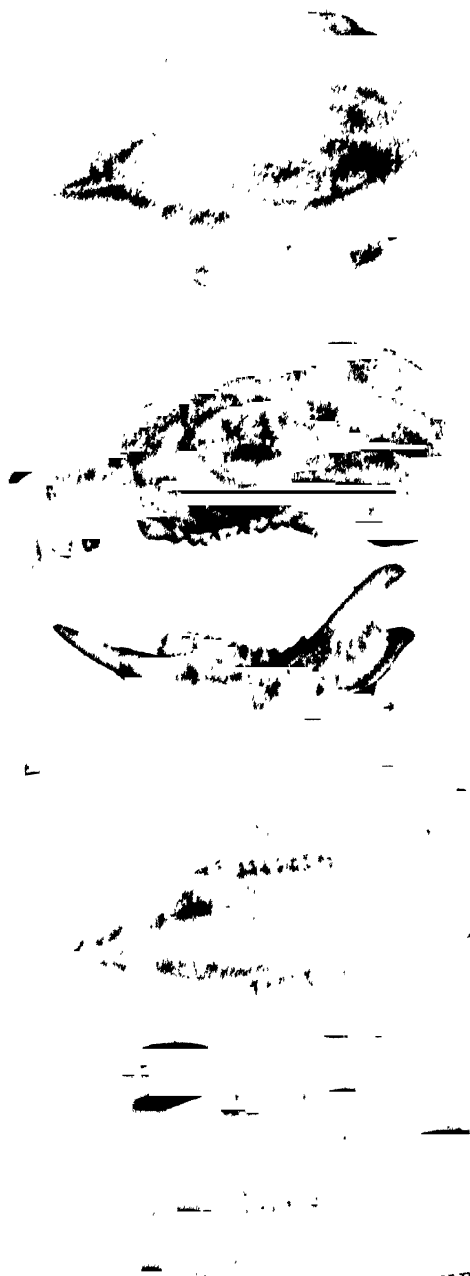


Fig. 7. *Bettongia cuniculus* Ogilby A M N H No 65273

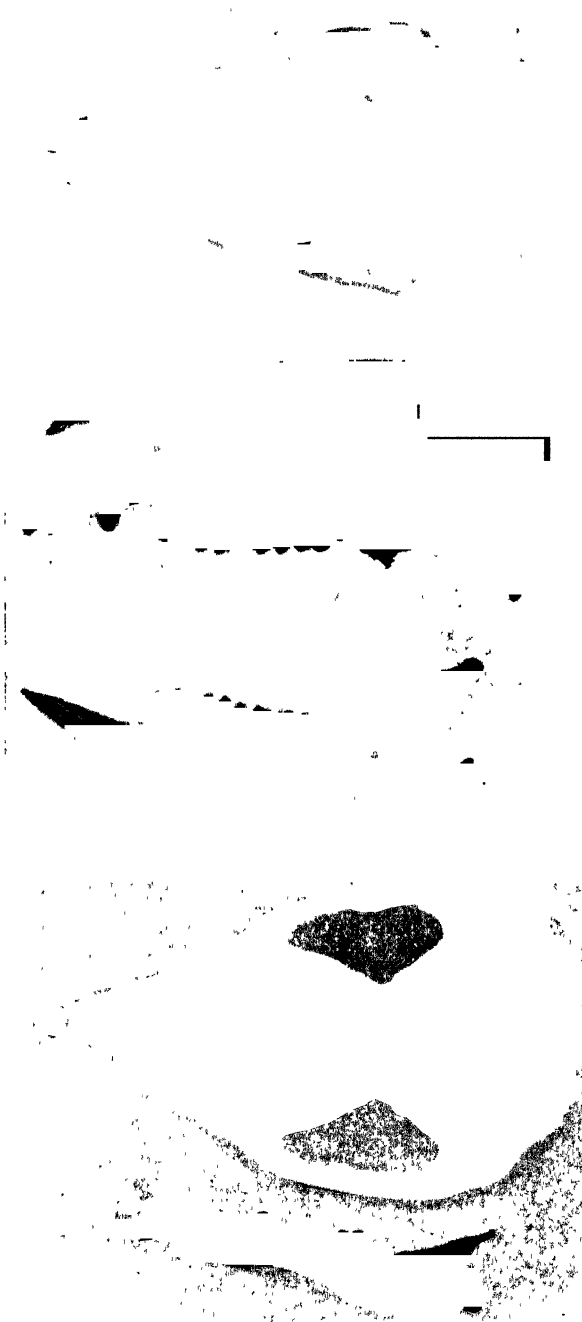


Fig. 8. *Aepyprymnus rufescens* Gray. A.M.N.H. No. 22788.

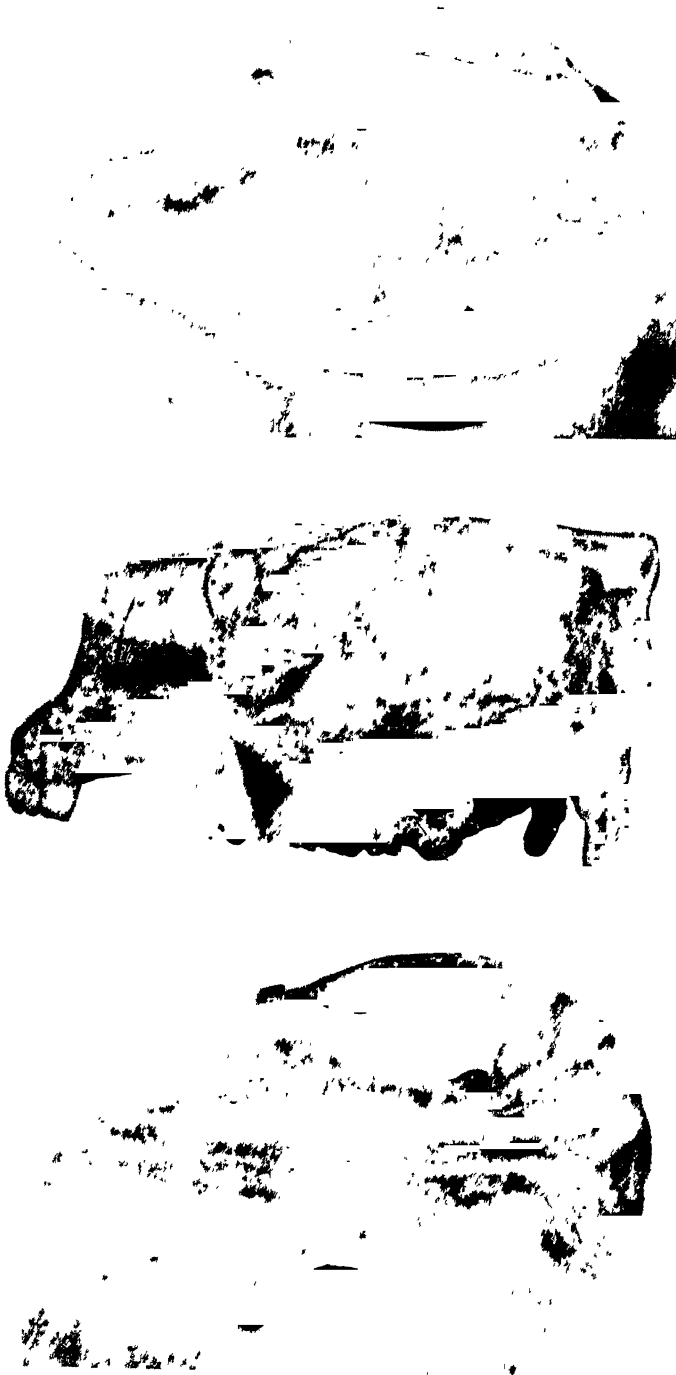


Fig. 9. *Sthenurus occidentalis* Glauert. Cast.

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Fig. 10. *Palorchestes*. Model restoration by H. C. Raven.

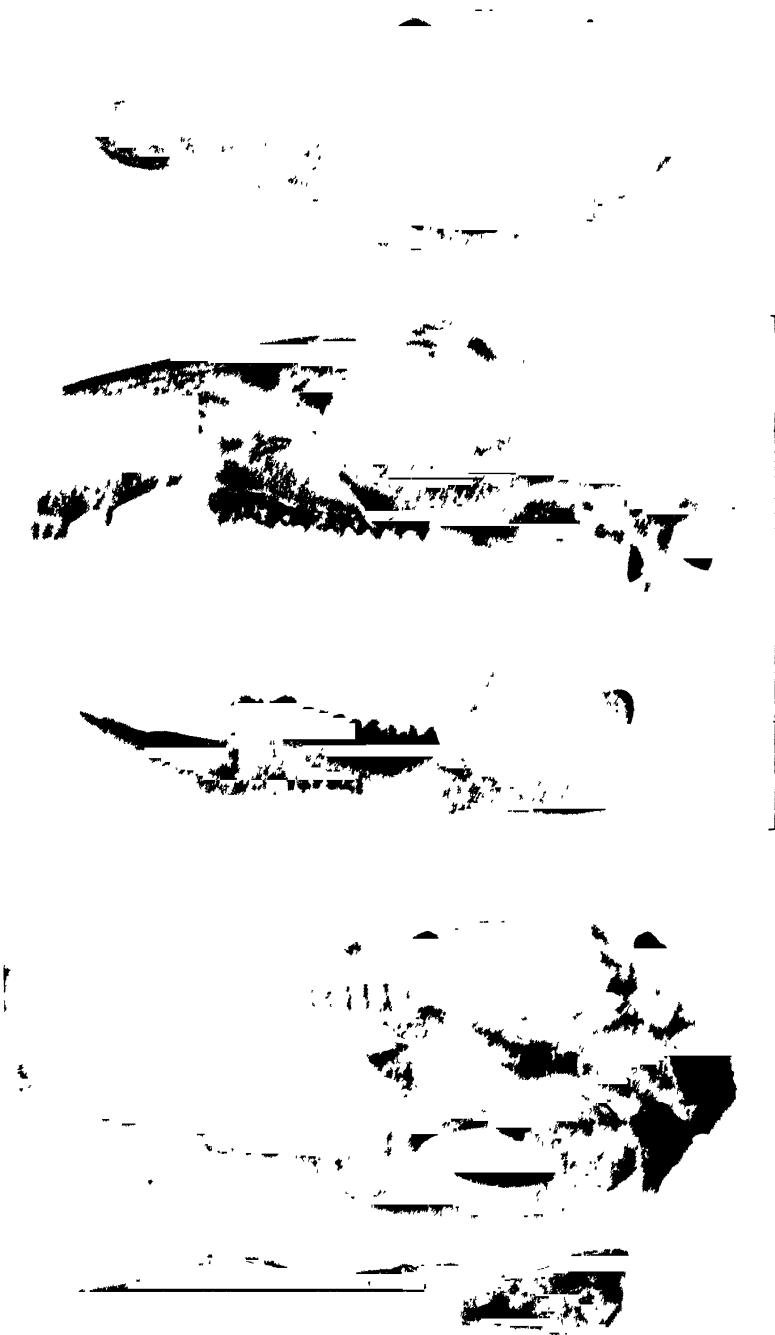


Fig. 11. *Dorcopsis (Dorcopsis) luctuosa* D'Alberty. A.M.N.H. No. 151821.

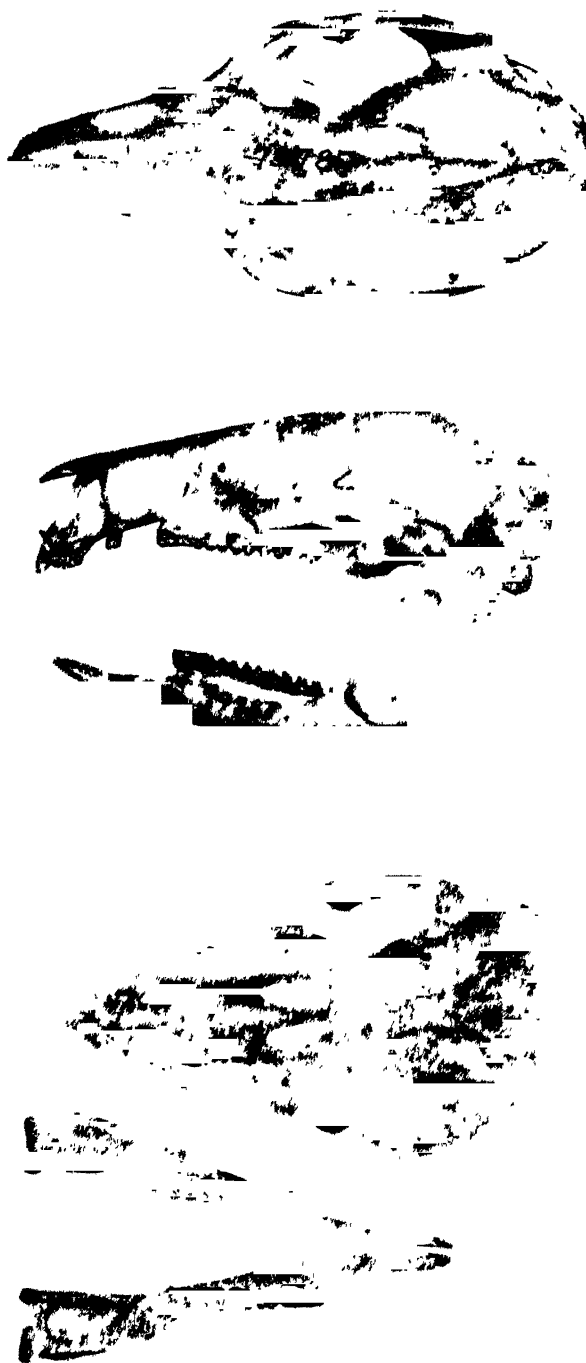
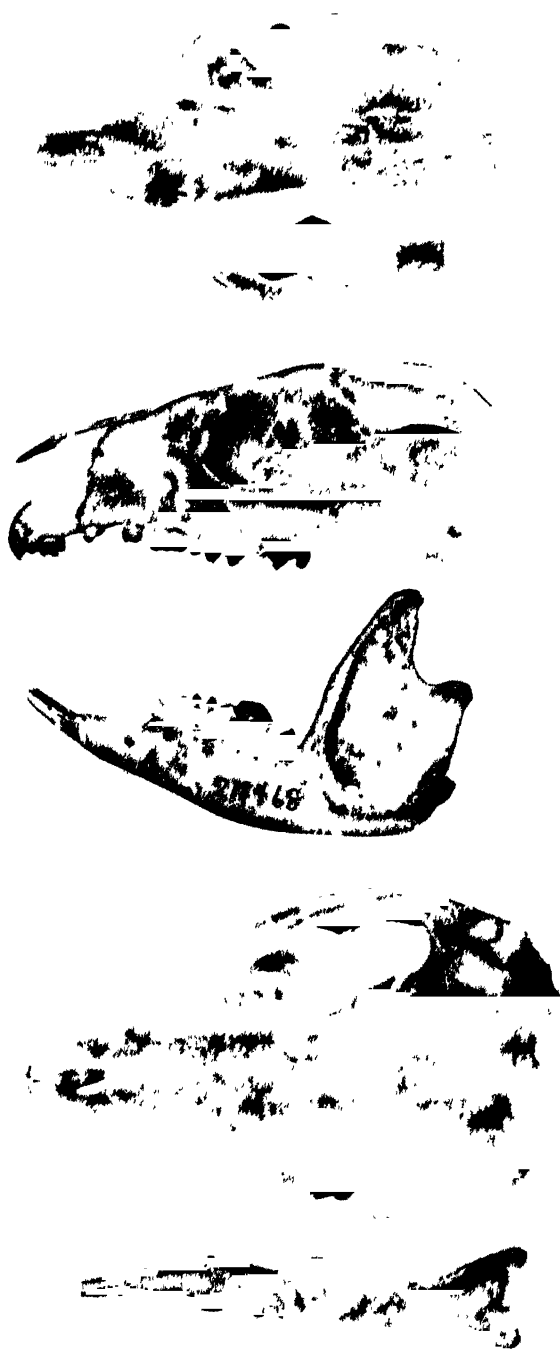


Fig. 12. *Dorcopsis (Dorcopsulus) macleayi* Miklouho-Maclay. A.M.N.H. No. 79787.





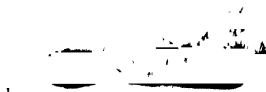
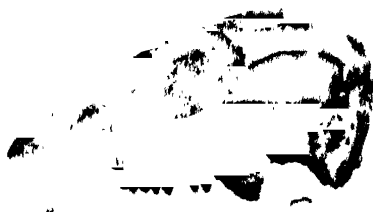


Fig 15 *Logostrophus fasciatus* Peron and Lesueur USNM No 218487



Fig 16 *Thylogale stigmatica* Gould A M N H No 65157



Fig. 17. *Setonix brachyurus* Quoy and Gaimard. Topotype E.M.N.H. No. 6.8.1.248.

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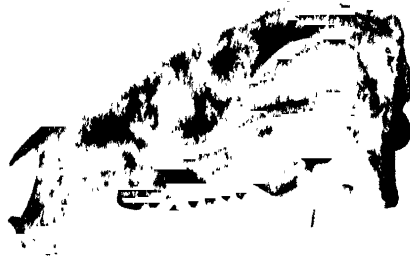


Fig 1b *Protemnodon taylori* Desmarest AMNH No 65127



Fig 19 *Onychogalea unguifer* Gould A M N H No 70400



Fig. 20. *Petrogale penicillata* Griffith. A.M.N.H. No. 65243.



Fig. 21. *Peradorcas concinna* Gould. Type, B.M.N.H. No. 42 5.26 20.

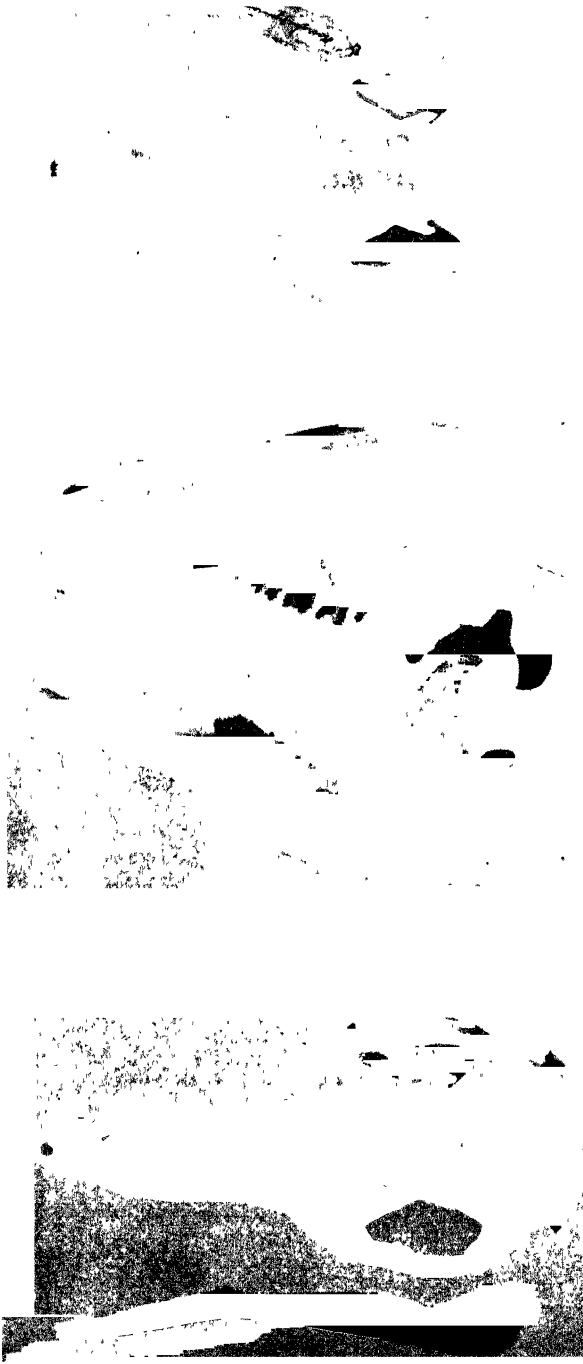


Fig. 22. *Macropus giganteus* Zimmerman. A.M.N.H. No. 66174.

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ADDITIONAL STUDIES OF THE PHALANGID FAUNA OF MEXICO. 1

BY CLARENCE J. AND MARIE L. GOODNIGHT

The present paper is a continuation of the studies by the authors on the phalangid fauna of Mexico (see Amer. Mus. Novitates, nos. 1163 and 1211, 1942; 1249, 1944; and 1281, 1945).

The majority of the specimens reported on are again the results of the collecting efforts of Drs. C. Bolívar, D. Peláez, F. Bonet, and B. F. Osorio Tafall. They were assisted in their work by Messrs. J. Alvarez, M. Cárdenas, M. Correa, M. Diaz, J. Hernandez, and the Misses Inez Piña, Marie L. Bolívar, and Clemencia Téllez.

A small but interesting collection was contributed by Dr. T. C. Schneirla from Chiapas and Vera Cruz.

The writers wish to thank Mr. Nathan

Banks of the Museum of Comparative Zoölogy, Cambridge, Massachusetts, for allowing them to examine several type specimens. The descriptions of *Kevonones mexicana* (Banks), *Poala mexicana* (Banks), and *Leiobunum denticulatum* Banks were made from the type specimens.

The authors also wish to express their appreciation to Miss Alice Gray of the American Museum of Natural History for her kindness in executing the drawing of the section of the dorsum of *Krusa stellata*, new species.

All holotypes of new species are deposited in the collection of the American Museum of Natural History. Paratypes are deposited in the collections of Dr. C. Bolívar and Dr. F. Bonet.

SUBORDER LANIATORES THORELL

PHALANGODIDAE Simon

Stygnopsinae Soerensen

CHAPULOBUNUS, NEW GENUS

Dorsum with five distinct areas, first area without a median line; boundaries of areas not parallel. Eye tubercle removed from the anterior margin of the cephalothorax, with paired spines. Second dorsal area with a median spine, third area with a larger median spine. Remaining areas and free tergites without median armature. Tarsal segments: 4-6-6-6. Distitarsus of first tarsus with two segments, second with three segments. Femur of the palpus with a median apical spine.

GENOTYPE: *Chapulobunus unispinosus*, new species.

Chapulobunus is most closely related to *Hoplobunus* Banks; however, it differs in the dorsal armature and in the number of tarsal segments.

Chapulobunus unispinosus, new species

Figures 6-9

FEMALE: Total length of body, 5.1 mm. Cephalothorax, 1.5 mm. Width of body at widest portion, 4.4 mm.

	I	II
Trochanter	0.4 mm.	0.6 mm.
Femur	1.8	3.1
Patella	0.7	1.1
Tibia	1.4	2.2
Metatarsus	1.8	2.8
Tarsus	1.0	1.8
Total	7.1 mm.	11.6 mm.
	III	IV
Trochanter	0.9 mm.	0.9 mm.
Femur	2.7	3.2
Patella	1.0	1.4
Tibia	2.0	3.2
Metatarsus	2.7	3.9
Tarsus	1.4	1.4
Total	10.7 mm.	14.0 mm.

Dorsum with five areas, the first area without a median line. Posterior boundaries of the first and second areas parallel; boundaries of the remaining areas not parallel. Second area with a small, median, hair-tipped spine. Posterior portion of the third area with a median large spine. This large spine almost obscures the posterior boundary of the third area in the adult specimens. The division is more evident in the immature specimens. Entire dorsal scute armed with many prominent tubercles which are more or less arranged in rows. These tubercles are lacking only at the boundaries between the areas. The tubercles of the lateral margin of the scute separated from those of the areas by a groove. Lateral margin in the region of the first area with a slight, light-colored bulge. Each free tergite with a compact row of tubercles. First and second free tergites each with a larger tubercle at the lateral margin. Cephalothorax with only a few scattered tubercles. Eye tubercle with a pair of small spines, also with scattered tubercles, removed from the anterior margin of the cephalothorax. Cephalothorax also with several small spines on the anterior lateral margin; the median anterior one of these is prolonged. Venter and coxae with scattered tubercles; spiracles widely expanded. Anal operculum tuberculate. Fourth coxa with a dorsal apical spine and with heavy tuberculations laterally. Second maxillary lobe apparently lacking, but with a suggestion of the division.

Legs clothed throughout with hairs. All segments but the tarsi heavily tuberculate. Fourth trochanter with a retrolateral apical spine. All femora with two apical dorsal spines. Fourth femur with a pro-lateral row of spines. Tarsal segments: 4-6-6-6. Distitarsus of first tarsus with two segments, second with three. Tarsal claws smooth, without false claw or scopula. Metatarsi not divided.

Palpus: trochanter, 0.5 mm. long; femur, 1.3; patella, 0.9; tibia, 1.1; and tarsus, 0.8. Total length, 4.6 mm. Palpus armed retrolaterally as in figure 6; pro-laterally armed as follows: femur with a median apical spine, patella with two

apical spines and one median spine, tibia with a row of four spines, and the tarsus with three. All segments except the tarsus dorsally tuberculate.

Chelicera normal, with scattered hairs, a few tuberculations on the proximal segments.

Dorsum brownish, with darker mottlings, which are particularly prominent on the cephalothorax, eyes black. Boundaries between the areas lighter. The projection of the lateral margin of the first area, that at the posterior lateral margin of the fifth area, and the lateral tubercles of the first and second free tergites lighter. Tips of median spines also lighter. Venter and coxae brown, appendages dark brown with some mottlings. Apical spines of the femora light, tarsi lighter, mottled.

TYPE LOCALITY: Female holotype and female paratypes from Chapulhuacán, Hidalgo, 1100 meters, May 19, 1944 (C. Bolívar and D. Peláez). Female paratypes from same locality, found under leaves in a tropical woods, May 19, 1944 (F. Bonet).

COSMETIDAE Simon

Cosmetinae Cambridge

Colima multimaculata Goodnight and Goodnight

Colima multimaculata GOODNIGHT AND GOODNIGHT, 1945, Amer. Mus. Novitates, no. 1281, pp. 4 and 5, figs. 12 and 13.

RECORD: Puerto del Presidente Ortiz Rubio, Mil Cumbres, Michoacán, 2150 meters, December 8, 1943 (C. Bolívar).

Cynorta formosa, new species

Figure 12

MALE: Total length of body, 4.7 mm. Cephalothorax, 1.5 mm. Width of body at widest portion, 3.9 mm.

	I	II
Trochanter	0.5 mm.	0.5 mm.
Femur	3.1	6.7
Patella	1.0	1.4
Tibia	2.0	5.2
Metatarsus	3.4	7.5
Tarsus	2.3	5.7
Total	12.3 mm.	27.0 mm.

	III	IV
Trochanter	0.6 mm.	0.8 mm.
Femur	4.8	6.8
Patella	1.4	1.5
Tibia	2.7	3.8
Metatarsus	5.0	7.2
Tarsus	2.9	3.6
Total	17.4 mm.	23.7 mm.

Dorsum smooth, paired tubercles on the first area; paired spines on the third, remaining areas and free tergites without median armature. A row of small tubercles across each free tergite. Eye tubercle low, unarmed except for a few small tubercles over each carina. Free sternites each with a transverse row of small tuberculations. Venter and coxae with scattered hairs. A transverse row of hair-tipped tubercles across the first coxa. Third coxa with a few teeth on the apical posterior margin. Fourth coxa with a blunt dorsal apical spine.

Legs clothed throughout with hairs. Scattered tubercles present on the femora, patellae, and tibiae. Tarsal segments: 6-16-8-10. Distitarsus of first tarsus with three segments, second with three. Basitarsus of first tarsus slightly enlarged.

Palpus: trochanter, 0.6 mm. long; femur, 1.3; patella, 0.9; tibia, 1.5; and tarsus, 0.8. Total length, 5.1 mm. Palpus characteristically flattened, a ventral row of teeth on the femur.

Chelicera with scattered hairs, slightly enlarged. Proximal segment with a few dorsal tubercles.

Dorsum dusky brown, with lighter mottlings particularly at the lateral portions and on the cephalothorax. A lighter patch extends across the eye. A broad band of white covers the posterior half of the cephalothorax, curving behind the eye tubercle and extending to the first area of the abdomen. Boundaries between the areas lighter. The lighter median line has numerous white fleckings. A bowed, very light line is present posterior to the spines of the third area. A very light transverse line is present in the median portion between the fourth and fifth areas. It is possible that in some specimens these lines may show up as white. Tubercles and tips

of spines white. Venter and appendages reddish brown, legs lighter distally.

TYPE LOCALITY: Male holotype from Tamazunchale, San Luis Potosí, May 20, 1944 (C. Bolívar).

This species is entirely different in color pattern and appearance from all other members of the genus *Cynorta* from the Mexican region.

Cynorta fortina Goodnight and Goodnight

Cynorta fortina GOODNIGHT AND GOODNIGHT, 1945, Amer. Mus. Novitates, no. 1211, pp. 3-4, fig. 12.

RECORD: Fortín, Vera Cruz, May, 1944 (C. Bolívar and I. Piña).

Cynorta skwarrae Roewer

Cynorta skwarrae ROEWER, 1931, Zool. Anz., vol. 95, p. 247, fig. 1.

RECORD: Fortín, Vera Cruz, June 28, 1944 (C. Bolívar and I. Piña).

Cynorta vokesi (Goodnight and Goodnight)

Metacynorta vokesi GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1163, pp. 10-11, fig. 2.

A study of additional specimens revealed that the tarsal count should be 6-10-7-7, distitarsus of first tarsus with three segments, second with three. This species is known only from Nayarit.

Cynortoides albiadpersus, new species

Figure 11

MALE: Total length of body, 4.7 mm. Cephalothorax, 1.7 mm. Width of body at widest portion, 3.8 mm.

	I	II
Trochanter	0.4 mm.	0.5 mm.
Femur	2.0	4.4
Patella	0.9	1.0
Tibia	1.6	3.2
Metatarsus	2.4	4.3
Tarsus	1.9	3.4
Total	9.2 mm.	16.8 mm.

	III	IV
Trochanter	0.5 mm.	0.6 mm.
Femur	3.2	4.2
Patella	1.1	1.1
Tibia	1.8	2.5
Metatarsus	3.0	4.5
Tarsus	1.9	2.4
Total	11.5 mm.	15.3 mm.

Dorsum smooth, first area with median paired tubercles, third and fourth areas with median paired spines. Eye tubercle low, smooth above. A transverse row of small tubercles across each free tergite. Anal operculum with scattered tuberculations. A transverse row of small tubercles on each free sternite. Coxae and venter with scattered hairs. Fourth coxa with a few small spines at the lateral apical portion and a few others at the distal dorsal. Third coxa without lateral teeth.

Legs clothed throughout with hairs, small tuberculations on the femora of all legs and on the patella, tibia, and metatarsus of the fourth leg. Tarsal segments: 6-13-7-8. Distitarsus of first tarsus with three segments, second with three. Basitarsus of first tarsus slightly enlarged.

Palpus: trochanter, 0.8 mm. long; femur, 1.5; patella, 0.8; tibia, 1.4; and tarsus, 0.6. Total length, 5.1 mm. Palpus characteristically flattened, a row of teeth on the ventral margin of the femur.

Chelicera enlarged, tuberculations on the proximal segment.

Dorsum dark brown with lighter mottlings. A lighter V-marking extends from the cephalothorax across the eye tubercle. An irregular white blotch at the posterior lateral portion of the cephalothorax. A few white dots in the boundary between the cephalothorax and abdomen, but no white V. Posterior boundaries of the first and second areas lighter, with a few white flecks. A bowed white line posterior to the spines of the third area. This line reaches completely across the dorsum, a small white bow posterior to the spines of the fourth area. Tips of spines and tubercles lighter. Free tergites without white markings. Venter dark reddish brown. Appendages lighter, with darker mottlings.

FEMALE: Total length of body, 5.1 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 3.6 mm.

Similar in appearance to the male, but without the enlargement of the chelicera and basitarsus of the first leg. One female has the white flecks between the cephalothorax and the abdomen almost united,

indicating that a V could be present in some specimens.

TYPE LOCALITY: Male holotype and female paratypes from Tamazunchale, San Luis Potosí, May 20, 1944 (C. Bolívar).

This is the first record of this genus in Mexico. Its related species are known only from the West Indies.

Eucynortoides maculata Roewer

Eucynortoides maculata ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 64, pl. 2, fig. 19; ROEWER, 1923, Die Weberknechte der Erde, p. 337, fig. 381.

RECORD: Fortín, Vera Cruz, May, 1944 (C. Bolívar and O. Piña).

Gueroma lineata Goodnight and Goodnight

Gueroma lineata GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1211, pp. 3, 4, fig. 12.

RECORD: Cayaco, Guerrero, December 28, 1944 (F. Bonet).

Kevonones mexicanus (Banks)

Figure 1

Erginus mexicanus BANKS, 1898, Jour. New York Ent. Soc., vol. 6, p. 181.

Rhaucus mexicanus ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 78; ROEWER, 1923, Die Weberknechte der Erde, p. 350.

Kevonones mexicanus CHAMBERLIN, 1925, Bull. Mus. Comp. Zool., vol. 68, no. 4, p. 240; ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26, p. 612.

MALE: Total length of body, 2.8 mm. Cephalothorax, 1.1 mm. Width of body at widest portion, 2.4 mm.

	I	II
Trochanter	0.3 mm.	0.3 mm.
Femur	1.6	2.7
Patella	0.6	0.8
Tibia	1.3	2.4
Metatarsus	1.4	2.7
Tarsus	1.2	2.4
Total	6.4 mm.	11.3 mm.

	III	IV
Trochanter	0.4 mm.	0.4 mm.
Femur	2.2	2.7
Patella	0.7	0.7
Tibia	1.6	2.2
Metatarsus	2.2	3.1
Tarsus	1.1	1.2
Total	8.2 mm.	10.3 mm.

Dorsum roughly granulate. Boundaries of areas not distinct. No median paired tubercles or spines present. A row of larger granulations on the lateral margins of the scute. A row of large tubercles across the posterior margins of the fifth area and each free tergite. Venter and coxae with granulations. A row of tuberculations across each free sternite. Anal operculum granulate.

Legs clothed throughout with scattered hairs. Trochanters, femora, and tibiae with numerous small tuberculations and scattered hairs. A larger tubercle on the retrolateral apical portion of the fourth trochanter. Third and fourth femora curved. Basal segments of third and fourth legs not enlarged over those of the first and second. Fourth coxa tuberculate. Tarsal segments: 5-9-6-6 or 7. Distitarsus of first tarsus with three segments; of second, three segments.

Palpus: trochanter, 0.3 mm. long; femur, 0.9; patella, 0.7; tibia, 0.8; and tarsus, 0.4. Total length, 3.1 mm. Palpus characteristically flattened; femur dorsally with a row of small spines and ventrally with a row of larger ones.

Chelicera with numerous granulations on the first segment. Entire animal light reddish brown, legs lighter.

TYPE LOCALITY: Male holotype from San José del Cabo, Baja California. In the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

Paravonones schneirlai, new species

Figure 17

FEMALE: Total length of body, 4.0 mm. Cephalothorax, 1.2 mm. Width of body at widest portion, 2.8 mm.

	I	II
Trochanter	0.4 mm.	0.4 mm.
Femur	1.6	2.6
Patella	0.6	0.9
Tibia	1.2	1.9
Metatarsus	1.7	2.4
Tarsus	1.3	2.5
Total	6.8 mm.	10.7 mm.

	III	IV
Trochanter	0.4 mm.	0.4 mm.
Femur	2.0	2.6
Patella	0.8	0.8
Tibia	1.4	1.9
Metatarsus	2.1	3.2
Tarsus	1.4	1.6
Total	8.1 mm.	10.5 mm.

Dorsum granulate, a pair of very low spines on the third area, remaining areas and free tergites without median armature. Eye tubercle wide, only granulate. Lateral margin of scute without a row of tuberculations. Free tergites with only a transverse row of fine hairs. Venter, coxae, and anal operculum only granulate, and with scattered hairs. Fourth coxa with a small tubercle at the dorsal apical portion.

Legs clothed throughout with scattered hairs, which are more numerous on the distal segment. Legs without tuberculations. Femora of third and fourth legs curved, only slightly heavier than the femora of the first and second legs. Tarsal segments: 5-8-6-7. Distitarsus of first tarsus with three segments; of second, three segments.

Palpus: trochanter, 0.6 mm. long; femur, 1.1; patella, 0.7; tibia, 1.0; and tarsus, 0.5. Total length, 3.9 mm. Palpus characteristically flattened, with scattered hairs. A ventral row of teeth on the femur. A few teeth at the proximal dorsal margin of the femur.

Chelicera with scattered hairs, first segment with a slight dorsal enlargement and with tuberculations on the retrolateral surface.

Entire body reddish brown, dorsal surface darker brown, with the areas outlined by lighter brown. Lighter brown mottlings on the cephalothorax, particularly over the eye tubercle where they approximate a V. Appendages lighter brown, with darker mottlings. Metatarsi and tarsi of legs pale, with dusky mottlings. Spines of third area darker. No white markings present on the animal.

TYPE LOCALITY: Female holotype from Rancho La Esperanza, 40 kilometers north of Escuintla, Chiapas, January 20, 1945 (T. C. Schneirla).

This species is related to *Paravonones*

biserratus Cambridge. *P. schneirlai* differs from *P. biserratus* in the fact that there are no white markings on the dorsal scute.

Poala mexicana (Banks)

Figures 2 and 3

Cynorta mexicana BANKS, 1898, Jour. New York Ent. Soc., vol. 6, p. 181.

Eucynortula mexicana ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 59; ROEWER, 1923, Die Weberknechte der Erde, p. 335.

Female: Total length of body, 5.1 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 4.4 mm.

	I	II
Trochanter	0.4 mm.	0.4 mm.
Femur	1.8	2.9
Patella	0.7	1.1
Tibia	1.3	2.4
Metatarsus	1.8	2.8
Tarsus	1.2	2.7
Total	7.2 mm.	12.3 mm.

	III	IV
Trochanter	0.6 mm.	0.6 mm.
Femur	2.7	3.1
Patella	0.9	1.2
Tibia	1.8	2.8
Metatarsus	2.4	3.6
Tarsus	1.1	1.2
Total	9.5 mm.	12.5 mm.

Dorsum almost smooth, a pair of very low tubercles or spines at the posterior portion of the third area. Several granulations laterad to each of these. Six small tubercles at the posterior median portion of the fourth area. A transverse row of small tubercles across the fifth area and free tergites. The anal operculum granulate. A transverse row of small tubercles

across each free sternite. Venter and coxae granulate. A transverse row of hair-tipped tubercles across coxae I to III. Coxa IV with a dorsal spine which is visible from above.

Legs: femora with a few scattered hair-tipped tubercles. Remainder of legs clothed with scattered hairs. A few small granulations on the patellae and tibiae. Third and fourth femora curved. Fourth femur with a distal retrolateral spine. Fourth tibia with a retrolateral row of spinules. Tarsal segments: 5-9-6-6. Distitarsus of first tarsus with three segments; of second, three.

Palpus: trochanter, 0.5 mm. long; femur, 0.9; patella, 0.8; tibia, 1.0; and tarsus, 0.5. Total length, 3.7 mm. Palpus characteristically flattened.

Chelicera normal.

Color reddish brown, with darker mottlings. Lighter markings outline the areas and indicate the median line. Appendages somewhat lighter.

TYPE LOCALITY: Female holotype from Orizaba, Mexico. No further data is presented on the type label.

Poala mexicana (Banks) differs from *Poala granulosa* Goodnight and Goodnight by having a smoother dorsum and by having an internal spine at the distal portion of the fourth femur.

Tecavonones clavipes Goodnight and Goodnight

Tecavonones clavipes GOODNIGHT AND GOODNIGHT, 1944, Ciencia, vol. 5, p. 107, figs. 5, 6.

RECORD: Campeche, Campeche, January 1, 1945 (M. Guerra).

SUBORDER PALPATORES THORELL

Tribe DYSPOI Hansen and Soerensen

ISCHROPSALIDAE Simon

Ruaxphilos petrunkevitchou Goodnight and Goodnight

Ruaxphilos petrunkevitchou GOODNIGHT AND GOODNIGHT, 1945, Trans. Connecticut Acad. Arts and Sci., vol. 36, pp. 249-252, figs. 1 and 2.

RECORD: Desierto de los Leones, D.F., March 12, 1944, under stones (M. Cárdenas).

Tribe EUPNOI Hansen and Soerensen

PHALANGIIDAE Simon

Leptobuninae Banks

Cosmobunus auratus, new species

Figures 19 and 20

MALE: Total length of body, 4.5 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 3.2 mm. Length of femora:

I, 7.8 mm.; II, 11.2 mm.; III, 7.8 mm.; IV, 10.3 mm.

Body roughly granulate. Eye tubercle towards the posterior portion of the cephalothorax, smooth above. Suprachelical lamella smooth, in the form of an expanded plate. Venter and coxae granulate. Coxae with numerous small tuberculations, with rows of lateral teeth at the anterior margins of all, and posterior margins of coxae III and IV. Lateral teeth rounded as in figure 19. Maxillary lobes of second coxae straight.

Legs clothed throughout with scattered hairs, small dark spines on the femora and patellae, more or less arranged in rows. Tibiae, metatarsi, and tarsi with many adhering hairs. Metatarsi with false articulations.

Palpus: trochanter, 0.3 mm. long; femur, 1.2; patella, 0.5; tibia, 0.8; and tarsus, 1.3. Total length, 4.1 mm. Palpus clothed throughout with hairs, many small spines on the ventral portion of the femur, the distal portion of the femur, the entire patella, and the proximal and ventral portion of the tibia. Tarsus with numerous hairs and a row of small spines on the inner margin. Tarsal claw untoothed. Patella without an anterior median apophysis.

Chelicera normal, with scattered hairs.

Dorsum, venter, and coxae bright reddish brown, nearly orange. Eye tubercle concolorous. Trochanters concolorous with the coxae, slightly darker on the anterior and posterior portions. Legs reddish brown, darker distally. Chelicera and palpus somewhat lighter than the body, tips of chelical claws black.

TYPE LOCALITY: Male holotype from Tepoztlán, Morelos, 1600 meters, August 13, 1944 (C. Bolívar).

This species is the first of the genus *Cosmobunus* Simon to be reported from the Western Hemisphere. It resembles most closely *Cosmobunus unicolor* Roewer of Spain. It differs by lacking the black eye tubercle and the black bases of the femora; also it is somewhat smaller in size, being only 4.5 mm. in length, while *C. unicolor* is 7.0 mm. The lateral teeth of the coxae are not large but are similar in appearance

to those illustrated in "Die Weberknechte der Erde," on page 873, figure 1034e.

The eye tubercle of the holotype is abnormal inasmuch as the eye on the right side is lacking. The left eye is almost to the top of the eye tubercle.

Trachyrhinus marmoratus Banks

Trachyrhinus marmoratus BANKS, 1894, Jour. New York Ent. Soc., vol. 2, p. 145; BANKS, 1901, Amer. Nat., vol. 35, p. 675; BANKS, 1902, Proc. Acad. Nat. Sci. Philadelphia, vol. 53, p. 593; ROEWER, 1910, Abhandl. Ver. Hamburg, vol. 19, no. 4, p. 268, pl. 5, figs. 40, 41, pl. 6, figs. 20, 21; ROEWER, 1923, Die Weberknechte der Erde, pp. 876, 877, fig. 1038a, b.

Trachyrhinus sonoranus CHAMBERLIN, 1925, Proc. California Acad. Sci., ser. 4, vol. 14, no. 9, pp. 172, 173.

Examination of the types of both *T. marmoratus* Banks and *T. sonoranus* Chamberlin revealed that they are identical.

Leiobuninae Banks

Leiobunum bolivari Goodnight and Goodnight

Leiobunum bolivari GOODNIGHT AND GOODNIGHT, 1945, Amer. Mus. Novitates, no. 1281, p. 9, fig. 18.

RECORDS: Zitácuaro, Michoacán, 2000 meters, December 6, 1943 (C. Bolívar). Acahuilzotla, Guerrero, January 4, 1945 (F. Bonet). Uruápan, Michoacán, May 25, 1941 (C. Bolívar and B. F. Osorio Tafall).

Leiobunum denticulatum Banks

Figures 22 and 23

Leiobunum denticulatum BANKS, 1900, Jour. New York Ent. Soc., vol. 8, p. 200; CAMBRIDGE, 1904, Biologia Centrali-Americana, Arachnida, vol. 2, p. 585; ROEWER, 1910, Abhandl. Ver. Hamburg, vol. 19, no. 4, p. 233; ROEWER, 1923, Die Weberknechte der Erde, p. 907.

MALE: Total length of body, 4.7 mm. Cephalothorax, 1.7 mm. Width of body at widest portion, 2.7 mm. Length of femora: I, 7.5 mm.; II, 14.8 mm.; III, 7.5 mm.; IV, 10.3 mm.

Dorsum finely granulate. Eye tubercle slightly canaliculate, with a row of several spinules over each eye. Venter and coxae finely granulate, a few larger granulations on the coxae. Lateral teeth on the anterior margins of all coxae and the posterior

margin of coxa IV. Supracheliceral lamella in the form of an expanded plate.

Legs: trochanters, femora, and patellae armed with small spines. Metatarsi and tarsi with numerous investing hairs. All metatarsi with false articulations.

Palpus: trochanter, 0.4 mm. long; femur, 2.2; patella, 1.1; tibia, 1.4; and tarsus, 1.4. Total length, 6.5 mm. Palpus large, incrassate. Femur curved, elevated to a distance of four times the height of the eye tubercle above the cephalothorax. Femur slightly enlarged at the distal portion. Ventrally a row of small teeth on the femur, and dorsally a few teeth at the distal portion. Patella with a row of teeth on the retrolateral ventral surface. Tibia with two rows of ventral teeth and numerous scattered ones at the proximal portion. Tarsus long and curved, a row of teeth on the inner margin.

Chelicera normal, with scattered hairs.

Penis straight shafted.

Dorsum with a dark brown median stripe beginning posterior to the eye tubercle and extending to the end of the abdomen. Lighter punctations present in the stripe. The sides of the abdomen and cephalothorax silvery with intricate dark brown mottlings. Eye tubercle light brown. Venter and coxae light brown. Trochanters and bases of femora dark brown, contrasting. Legs light brown. Patellae dark brown. Chelicera and palpus light.

FEMALE: Total length of body, 5.2 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 3.4 mm.

Similar in appearance to male, but the palpus is only slightly elevated above the surface of the cephalothorax.

TYPE LOCALITY: Male and female types from Cuernavaca, Morelos. Deposited in the collection of the Museum of Comparative Zoology, Cambridge, Massachusetts.

This species belongs to the group of the genus *Leiobunum* that has heavy palpi and a straight-shafted penis. The palpus of the male of this animal is much heavier than that of other known species of the genus *Leiobunum* from Mexico.

Leiobunum dromedarium Cambridge

Leiobunum dromedarium CAMBRIDGE, 1904, Biologia Centrali-Americana, Arachnida, vol. 2, p. 583, pl. 54, figs. 19, 20; ROEWER, 1910, Abhandl. Ver. Hamburg, vol. 19, no. 4, p. 235, pl. 3, fig. 25; ROEWER, 1923, Die Weberknechte der Erde, p. 908, fig. 1058.

RECORD: Campeche, Campeche, January 1, 1945 (M. Guerra).

Leiobunum escondidum Chamberlin

Figure 21

Leiobunum escondidum CHAMBERLIN, 1925, Proc. California Acad. Sci., ser. 4, vol. 14, no. 9, p. 171.

MALE: Total length of body, 4.9 mm. Cephalothorax, 1.3 mm. Width of body at widest portion, 3.1 mm. Length of femora: I, 8.4 mm.; II, 12.2 mm.; III, 9.0 mm.; IV, 11.1 mm.

Abdomen of male somewhat swollen; dorsum roughly granulate. Eye tubercle in the anterior third of the cephalothorax, canaliculate, smooth above. Supracheliceral lamella in the form of an expanded plate which terminates in a median point. Venter and coxae finely granulate. Well-developed rows of teeth on the anterior and posterior margins of all coxae.

Legs with spinules on all segments but the metatarsi and tarsi. These are larger on the femora and more or less arranged in rows. Metatarsi and tarsi with thick covering of adhering hairs; the apical portion of the tibia is also clothed with thick hairs. Metatarsi with false articulations. Two black spines at each false articulation of the metatarsi and at the true articulations of the tarsi.

Palpus: trochanter, 0.3 mm. long; femur, 1.2; patella, 0.6; tibia, 0.8; and tarsus 1.2. Total length, 4.1 mm. Palpus clothed throughout with scattered hairs; small, scattered, spine-like teeth on the femur, patella, and proximal portion of the tibia. Tibia and tarsus clothed with adhering hairs, tarsus with numerous hairs which extend at right angles. Patella without an apophysis, though thickened at the anterior median portion.

Chelicera normal, with scattered hairs. Spine-like hairs present just proximal to the claws on the second segment. A thicker patch present on the prolateral side.

Penis alate.

Dorsally the animal is brown. An indefinite median darker brown stripe extending from the anterior margin to the posterior portion of the abdomen, enclosing the eye tubercle. On either side of median stripe, a lighter portion on the cephalothorax, this bordering area is nearly white. Posterior portion of abdomen darker. Lateral margin of the cephalothorax lined in dark brown. Eyes brown at the base, lighter above. A dark brown median line between the eyes, eyes black. Venter and coxae buff. Coxal teeth darker. Trochanters and bases of femora dark brown on the anterior and posterior portions so that they appear to contrast slightly with the coxae. Legs light brown, patellae darker, spines darker. Chelicera and palpus light, concolorous with the venter.

FEMALE: Total length of body, 5.4 mm. Cephalothorax, 1.1 mm. Width of body at widest portion, 3.7 mm.

Identical in appearance with the male.

RECORD: La Burrera, Baja California, August 22, 1944 (M. Correa).

These specimens were compared with Chamberlin's type specimens. The latter were slightly darker, but otherwise were identical in appearance. This color may have been due to the method of preservation.

Leiobunum guerreroensis, new species

Figure 28

MALE: Total length of body, 3.4 mm. Cephalothorax, 0.7 mm. Width of body at widest portion, 2.0 mm. Length of femora: I, 10.6 mm.; II, 15.3 mm.; III, 10.1 mm.; IV, 12.7 mm.

Dorsum granulate, eye tubercle unarmed, canaliculate, on posterior portion of cephalothorax. Venter clothed only with scattered hairs. Coxae with scattered granulations. All coxae with anterior and posterior rows of well-developed teeth. Supracheliceral lamella in the form of an expanded plate, which is projected into a spine in the median portion.

Legs clothed throughout with scattered hairs. Small spines present on the trochanters and femora; these are more or less arranged in rows on the femora,

patella with a few widely scattered spinules. These are more closely spaced at the distal margin. Tibiae, metatarsi, and tarsi with investing hairs. Metatarsi with false articulations.

Palpus: trochanter, 0.3 mm. long; femur, 1.1; patella, 0.4; tibia, 0.6; and tarsus, 1.1. Total length, 3.5 mm. Palpus clothed throughout with hairs which are more numerous on the tibia. A few spinules on the ventral margin of the femur. Femur not elevated above the margin of the cephalothorax. Patella without an apophysis.

Chelicera normal, with scattered hairs.

Penis alate.

Dorsal portion of abdomen dark golden brown, metallic in some specimens. The median portion is somewhat lighter, on some specimens a lighter marginal band. This golden brown marking extends as a median band across the cephalothorax, enclosing the eye tubercle. On both sides of the cephalothorax a lighter portion, silvery in spots. Eye tubercle brown, with a black ring around each eye. Venter and coxae buff in color, marginal teeth somewhat darker. Trochanters and bases of femora dark brown, contrasting with the coxae, remainder of legs lighter brown, darker distally. Palpus and chelicera very light.

FEMALE: Total length of body, 3.3 mm. Cephalothorax, 1.2 mm. Width of body at widest portion, 2.3 mm.

Identical in appearance with the male.

TYPE LOCALITY: Male holotype and female paratype from Acapulco, Guerrero, December 27, 1944 (F. Bonet).

This species is most closely related to *Leiobunum bolivari* Goodnight and Goodnight, differing by having the lighter lateral portion on the cephalothorax and in lacking the white spots at the posterior portion of the cephalothorax. Also this species lacks the conspicuously white coxae with dark marginal teeth such as *L. bolivari* has.

Leiobunum hoogstraali Goodnight and Goodnight

Leiobunum hoogstraali GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1163, p. 12, fig. 20.

RECORD: Chupícuaro, Michoacán, 2100 meters, December 8, 1943 (C. Bolívar).

***Leiobunum nycticorpus* Goodnight and Goodnight**

Leiobunum nycticorpus GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1163, pp. 12, 13, figs. 23, 24.

RECORDS: El Salto, San Luis Potosí, May 22, 1944 (C. Bolívar); Chapulhuacán, Hidalgo, 1100 meters, May 19, 1944 (C. Bolívar and D. Peláez).

***Leiobunum patzquarum* Goodnight and Goodnight**

Leiobunum patzquarum GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1211, pp. 8, 9, fig. 23.

RECORD: Monterrey (Chipinque), Nuevo Leon, June 19, 1944 (F. Bonet).

***Leiobunum royalii*, new species**

Figure 29

FEMALE: Total length of body, 4.2 mm. Cephalothorax, 1.6 mm. Width of body at widest portion, 3.2 mm. Length of femora: I, 8.1 mm.; II, 13.6 mm.; III, 7.6 mm.; IV, 11.1 mm.

Dorsum granulate, eye tubercle on the posterior third of the cephalothorax, smooth above, canaliculate. Suprachelicer lamella in the form of an expanded plate. Free sternites smooth, coxa and genital operculum with scattered small tuberculations and scattered hairs. A row of teeth present on the anterior margins of all coxae and on the posterior margin of coxa IV.

Legs clothed throughout with scattered hairs. Femora armed with small spines which are more or less arranged in rows. Tibiae, metatarsi, and tarsi thickly clothed with investing hairs. Metatarsi with false articulations. Several small spines at the apical portion of the femora and patellae.

Palpus: trochanter, 0.4 mm. long; femur, 1.3; patella, 0.5; tibia, 0.9; and tarsus, 1.6. Total length, 4.7 mm. Palpus clothed throughout with scattered hairs, more numerous on the tarsus. Small dark spines on the dorsal surface of the patella. A ventral row of spine-like hairs on the femur. Tibia with a slight proximal and

ventral enlargement and with many long investing hairs. Patella without apophysis. Femur not elevated above the eye tubercle.

Chelicera normal, with scattered hairs.

Dorsum yellowish with a darker median stripe. Lateral portion of abdomen with many silvery punctations. In the median stripe, a few smaller silvery punctations. Cephalothorax mottled. Eye tubercle light at the base, dark above. An irregular dark brown line margining the abdomen. Venter and coxae pale. Trochanters and bases of femora black, contrasting strongly. Remainder of legs dark brown, lighter distally. A lighter brown portion present in the middle of the femora and tibiae. Chelicera and palpus very light, concolorous with the venter.

MALE: Total length of body, 4.5 mm. Cephalothorax, 1.1 mm. Width of body at widest portion, 2.9 mm. Length of femora: I, 9.0 mm.; II, 15.4 mm.; III, 9.0 mm.; IV, 13.6 mm.

Similar in appearance to female. One male lacks the median stripe and the dark bordering the abdomen.

TYPE LOCALITY: Female holotype and female paratypes from Chapulhuacán, Hidalgo, May 19, 1944 (C. Bolívar, D. Peláez). Male and female paratypes from Chapulhuacán, Hidalgo, May 19, 1944 (F. Bonet). Male paratype from El Pujal, San Luis Potosí, May 25, 1944 (C. Bolívar).

This species is similar in appearance to *Leiobunum nigripes* Weed, differing in having a lighter venter and the silvery spots on the dorsum.

Gagrellinae Thorell

***Krusa annulata* Goodnight and Goodnight**

Krusa annulata GOODNIGHT AND GOODNIGHT, 1945, Amer. Mus. Novitates, no. 1281, pp. 14, 15, fig. 17.

RECORD: Acapulco, Guerrero, December 27, 1944 (F. Bonet).

***Krusa flava*, new species**

Figures 25-27

MALE: Total length of body, 2.4 mm. Cephalothorax, 0.9 mm. Width of body at widest portion, 2.1 mm. Length of femora:

I, 7.7 mm.; II, 15.3 mm.; III, 8.1 mm.; IV, 10.2 mm.

Dorsum finely granulate, supracheliceral lamella in the form of an expanded plate. Eye tubercle at the posterior portion of the cephalothorax, canaliculate, smooth above. Venter and coxae finely granulate, rows of three-pronged teeth on the anterior and posterior margins of all coxae.

Legs with scattered hairs, small spines present on the trochanters, femora, patellae, and the proximal portion of the tibiae. These are heavier and arranged more or less in rows on the femora. Many small investing hairs on the tibiae, tarsi, and metatarsi. Metatarsi with false articulations. Nodules: 0-1-0-0.

Palpus: trochanter, 0.2 mm. long; femur, 0.7; patella, 0.3; tibia, 0.3; and tarsus, 0.3. Total length, 1.8 mm. Palpus clothed throughout with hairs which are more numerous on the tarsus. Ventral portion of femur with a row of small spines. Small scattered spines over the patella. Patella without anterior median apophysis but the anterior median portion swollen. Dorsal portion of patella with fine striations.

Chelicera normal, with scattered hairs.

Dorsum light orange, with brown pencilings on the lateral and posterior portions of the cephalothorax and in front of the eye tubercle. Segments of the abdomen indefinitely indicated by brown. Eye tubercle black above, light at the base. Venter and coxae light yellowish. Trochanters and bases of femora dark brown, contrasting. Legs light brown, distal portion of femora, patellae, and tibiae darker. Palpus concolorous with the venter, with some brown shadowings on the dorsal portion of the patella. Chelicera very light.

FEMALE: Total length of body, 2.4 mm. Cephalothorax, 0.8 mm. Width of body at widest portion, 1.9 mm. Length of femora: I, 6.9 mm.; II, 13.2 mm.; III, 6.7 mm.; IV, 9.6 mm.

Identical in appearance with the male.

TYPE LOCALITY: Male holotype and male and female paratypes from Chapulhuacán, Hidalgo, 1100 meters, May 19, 1944 (C. Bolívar and D. Peláez).

Krusa flava is most closely related to *K. annulata* Goodnight and Goodnight, but differs in lacking the silvery markings on the cephalothorax.

***Krusa metallica*, new species**

Figure 18

FEMALE: Total length of body, 3.5 mm. Cephalothorax, 1.0 mm. Width of body at widest portion, 2.2 mm. Length of femora: I, 7.1 mm.; II, 11.8 mm.; III, 6.8 mm.; IV, 8.8 mm.

Dorsum smooth except for the anterior six segments of the abdomen which are granulate. Eye tubercle on the posterior third of the cephalothorax, canaliculate, smooth above, straight in front, constricted at the base. Supracheliceral lamella in the form of an expanded plate. Venter and coxae smooth. Coxae with well-developed rows of three-pronged teeth on the anterior and posterior margins of all coxae.

Legs clothed throughout with hairs, small spines on the trochanters and the femora. Numerous adhering hairs on the tibiae, metatarsi, and tarsi. Metatarsi with false articulations. Nodules: 0-1-0-0.

Palpus: trochanter, 0.3 mm. long; femur, 0.7; patella, 0.3; tibia, 0.5; and tarsus, 1.1. Total length, 2.9 mm. Palpus with scattered hairs which are more numerous on the tarsus. Small spines present on the ventral surface of the femur and the dorsal surface of the patella. Patella without an apophysis.

Chelicera normal, with scattered hairs. A series of small spine-like hairs at the distal median portion of the first segment.

Dorsal portion of cephalothorax light brown, with darker mottlings. Eye tubercle dark brown, with lighter patches above the eyes. Dorsal portion of the first six segments of the abdomen metallic green in appearance. Darker punctations mark the borders of the dorsal segments. Posterior portion of abdomen brown with metallic areas in the median portion of some of the segments. Venter and coxae light brown, concolorous with the cephalothorax. Trochanters and bases of femora dark brown, contrasting with the coxae. Legs brownish, patellae and tibiae dark brown. Distal portion of the tibiae and

proximal portion of metatarsi white on some of the legs. The presence of this white is very variable. On a large series examined, this white was consistently present on the fourth leg, usually on the second, and occasionally on the third. Chelicera and palpus concolorous with the venter.

TYPE LOCALITY: Female holotype from Chapulhuacán, Hidalgo, May 19, 1944 (F. Bonet). Female paratypes from Chapulhuacán, Hidalgo, 1100 meters (F. Bonet, C. Bolívar, and D. Peláez).

This species is distinctive from other members of the genus *Krusa* because of the metallic appearance of the dorsum.

***Krusa stellata*, new species**

Figures 13-16

MALE: Total length of body, 3.3 mm. Cephalothorax, 0.8 mm. Width of body at widest portion, 2.2 mm. Length of femora: I, 5.3 mm.; II, 10.1 mm.; III, 5.8 mm.; IV, 8.4 mm.

Dorsum thickly covered with an interlacing series of ridges which form small depressions over the entire abdomen. Scattered over all these ridges are numerous sharp five-pronged teeth, similar in appearance to the lateral teeth of the coxae. These five-pronged teeth extend over the entire cephalothorax. Eye tubercle canalliculate, constricted at the base; the five-pronged teeth extend on the eye tubercle, forming a ring around each eye, but are absent from the interocular depression. Free sternites with flattened granulations. The five-pronged teeth of the abdomen extend on the lateral portions of the body. Median portion of the free sternites with a transverse row of simple spinules. Anal operculum with a few scattered five-pronged teeth and a few simple spinules. Coxae and genital operculum with the same plate-like granulations and scattered simple spines; anterior and posterior rows of teeth three-pronged, on all margins of the coxae but the posterior margin of the third. Genital operculum with lateral rows of teeth. Supracheliceral lamella in the form of a rounded projection on the margin of which there is a row of three-pronged teeth.

Legs with scattered hairs, investing hairs

on the metatarsi and tarsi. Metatarsi with false articulations. Small spines present on all segments except the metatarsi and tarsi. All segments but metatarsi and tarsi with fine striations. Nodules: 0-1-0-0.

Palpus: trochanter, 0.3 mm. long; femur, 0.8; patella, 0.3; tibia, 0.6; and tarsus, 1.1. Total length, 3.1 mm. Palpus with numerous scattered hairs. Numerous spines present on the ventral portion of the femur, dorsal portion of the patella, and the entire tibia. Patella without apophysis.

Chelicera normal, with scattered hairs.

Penis alate.

Dorsum brownish, with some darker and lighter mottlings, lighter towards the pleura. Teeth of dorsum darker. Cephalothorax with darker brown in the median portion, lighter at the sides. Eye tubercle brownish. Venter and coxae lighter, teeth and spines dark. Trochanters of legs dark brown at the anterior and lateral regions, contrasting with the coxae, bases of femora dark brown, remainder of legs lighter brown, somewhat darker distally. These markings show as a white or lighter-colored band at the distal portion of the tibia and the proximal portion of the metatarsus of the second leg. Palpus light brown, with darker brown mottlings on the femur, patella, and tibia. Chelicera light brown.

FEMALE: Total length of body, 5.1 mm. Cephalothorax, 2.2 mm. Width of body at widest portion, 3.5 mm.

Similar in appearance to the male.

TYPE LOCALITY: Cascada Sararacua, Michoacán (near Uruápan), May 26, 1941 (C. Bolívar and B. F. Osorio Tafall).

Krusa stellata differs from other members of the genus *Krusa* by the extreme spination of the dorsum.

***Krusa tuberculata*, new species**

Figure 10

MALE: Total length of body, 2.2 mm. Cephalothorax, 0.8 mm. Width of body at widest portion, 1.6 mm. Length of femora: I, 5.0 mm.; II, 8.1 mm.; III, 5.1 mm.; IV, 6.6 mm.

Dorsum covered over its entire surface

with small circular ridges, causing the surface to be covered with small pits. Eye tubercle at the posterior portion of the cephalothorax, slightly canalicate, constricted at the base, six to eight small tubercles in a row over each eye, and a few scattered irregularly in between the rows. Supracheliceral lamella extended into a point in the median portion, with several small projections at the tip. Anal operculum, venter, and coxae with numerous rounded elevations. These are more or less arranged in rows on the free sternites. All coxae with well-developed rows of teeth on the anterior and posterior margins. These teeth are typically three-pronged.

Legs with scattered hairs and with numerous investing hairs on the metatarsi and tarsi. All segments except the metatarsi and tarsi thickly armed with spinules. Metatarsi with false articulations. Nodules: 0-1-0-0.

Palpus: trochanter, 0.3 mm. long; femur, 0.6; patella, 0.3; tibia, 0.4; and tarsus, 0.6. Total length, 2.2 mm. Palpus clothed throughout with hairs, which are more numerous on the tarsus. The tarsus also has investing hairs. Ventral portion of the femur with a row of sharp spinules. Femur not elevated. All segments but the tarsus thickly armed with small dark spinules. Patella with a long slender anterior median apophysis.

Chelicera normal, with scattered hairs.

Dorsum brownish, mottled lighter and dark. Darker mottlings in the margin of the cephalothorax, and in the subobsolete darker median band on the abdomen. Eye tubercle very dark brown above, lighter at the base. Venter and coxae brown, darker brown at the distal portions of the coxae. Trochanters dark brown at anterior and posterior portions, lighter on the lateral portions. Bases of femora light brown, remainder of legs lighter brown, darker distally. Palpus dark brown, mottled, tarsus light. Chelicera light in color, claws tipped with black.

FEMALE: Total length of body, 3.6 mm. Cephalothorax, 1.0 mm. Width of body at widest portion, 2.5 mm.

Identical in appearance with the male.

TYPE LOCALITY: Male holotype and

male and female paratypes from Cascada Sararacua, Michoacán (near Uruápan), May 26, 1941 (C. Bolívar and B. F. Osorio Tafall).

This species differs from the other described species of the genus *Krusa* in the extremely roughened condition of the body.

Prionostemma coxale (Banks)

Leiobunum coxale BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 233.

Prionostemma coxale ROEWER, 1910, Abhandl. Ver. Hamburg, vol. 19, no. 4, p. 180; ROEWER, 1923, Die Weberknechte der Erde, p. 1080.

RECORD: Fortín, Vera Cruz, June 28, 1944 (C. Bolívar and I. Piña).

Prionostemma lubeca, new species

Figure 24

MALE: Total length of body, 3.2 mm. Cephalothorax, 0.6 mm. Width of body at widest portion, 1.4 mm. Length of femora: I, 7.7 mm.; II, 13.5 mm.; III, 7.6 mm.; IV, 10.8 mm.

Dorsum finely granulate, eye tubercle at the posterior portion of the cephalothorax, constricted at the base, slightly canalicate. Smooth above except for a few small granulations and hairs. Abdomen much shortened. Supracheliceral lamella extended into a median projection. Venter and coxae with scattered granulations. All coxae with anterior and posterior marginal rows of blunt three-pronged teeth.

Legs with scattered hairs, investing hairs on the metatarsi and tarsi. Metatarsi with false articulations. Femora and patellae with small scattered spines. Nodules: 0-3-0-1.

Palpus: trochanter, 0.3 mm. long; femur, 0.9; patella, 0.3; tibia, 0.4; and tarsus, 0.9. Total length, 2.8 mm. Palpus clothed throughout with hairs, a ventral row of teeth on the proximal portion of the femur. Patella with a few scattered minute spinules, without an apophysis, only slightly swollen at the distal medial portion.

Chelicera normal.

Penis alate.

Dorsum golden with darker shadings. Eye tubercle light at the base, dark brown

above. Venter and coxae golden, lighter than the dorsum. Trochanters and bases of femora with darker brown mottlings, contrasting somewhat with the coxae. The darker brown mottlings of the trochanters are more prominent at the anterior and posterior portions, remainder of legs light brown, darker distally. Palpus and chelicera light yellowish.

FEMALE: Total length of body, 2.8 mm. Cephalothorax, 1.5 mm. Width of body at widest portion, 2.1 mm.

Identical in appearance to male, but the patella of the palpus has an apophysis on the anterior median portion.

TYPE LOCALITY: Male holotype and male and female paratypes from Finca Lubeca, 2 kilometers north of Hiuxtla, Chiapas (T. C. Schneirla).

Prionostemma lubeca differs from other members of the genus *Prionostemma* by having a golden dorsum and somewhat darker trochanters.

Prionostemma victoriae, new species

Figure 4

MALE: Total length of body, 2.7 mm. Cephalothorax, 0.9 mm. Width of body at widest portion, 1.8 mm. Length of femora: I, 9.2 mm.; II, 16.7 mm.; III, 8.4 mm.; IV, 11.2 mm.

Dorsum roughly granulate, with minute depressions. Eye tubercle at the posterior portion of the cephalothorax, canaliculate, smooth except for a few tubercles at the anterior portion of the carina. Supracheliceral lamella prolonged into a median projection. Venter and coxae thickly covered with small tuberculations. Three-pronged teeth present on the anterior margins of all coxae and the posterior margins of all coxae but the third.

Legs with a few scattered hairs. Investing hairs present on the tibiae, metatarsi,

and tarsi. Trochanters and femora with scattered small spines which are more or less arranged in rows on the femora. Nodules: 0-3-0-1.

Palpus: trochanter, 0.3 mm. long; femur, 0.7; patella, 0.4; tibia, 0.5 mm.; and tarsus, 0.9 mm. Total length, 2.8 mm. Palpus with scattered hairs which are more numerous on the tarsus. Ventral portion of the femur with a row of spinules. Distal portion of the femur, tibia, and tarsus with scattered small dark spines. Tarsus with investing hairs. Anterior median portion of the patella with a short apophysis.

Chelicera normal, with scattered hairs.

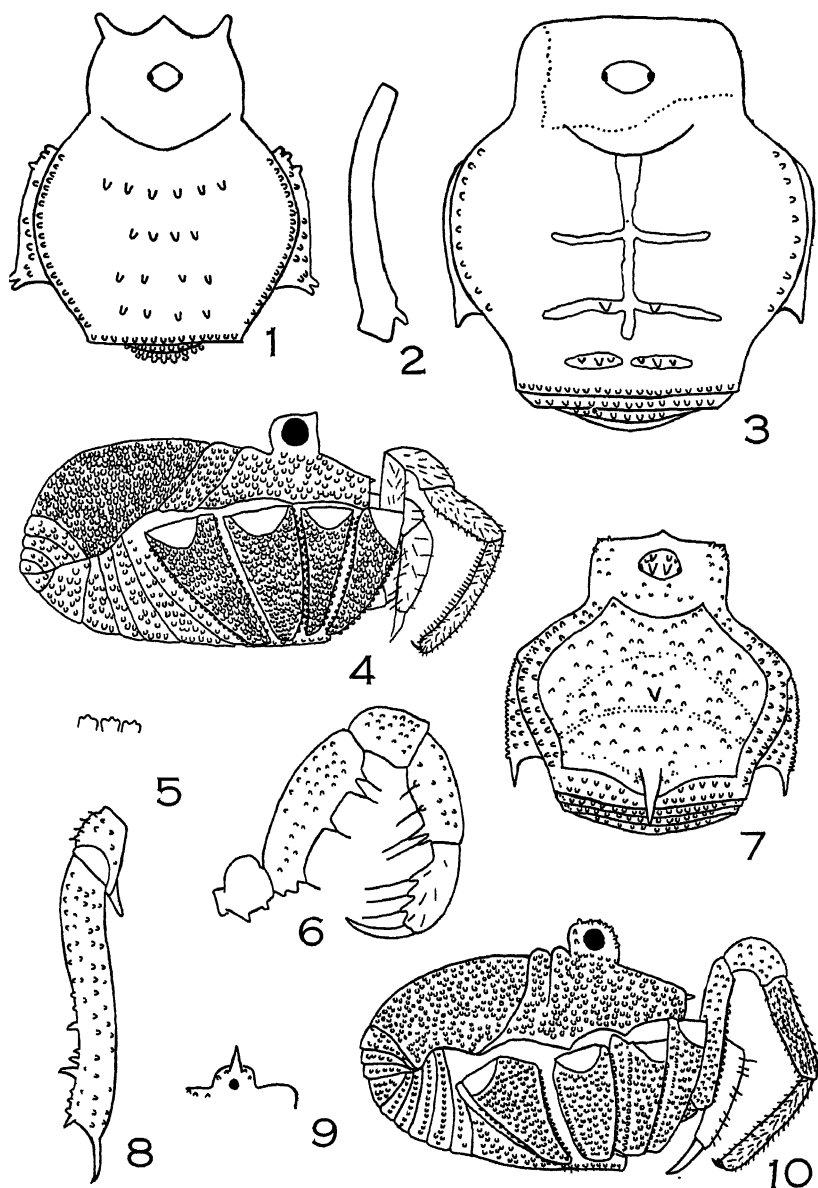
Dorsum dark brown to black, sometimes with lighter punctations in the paler specimens. Eye tubercle dark, concolorous with the dorsum. In some specimens the eye tubercle is particularly light. Venter and coxae lighter golden or brownish. Trochanters and bases of femora dark brown, contrasting, remainder of legs brown, lighter distally. Most specimens have light yellow markings at the nodules on the femora; there are also other pale bands present which sometimes make the number of nodules difficult to determine. Some specimens have a white area at the junction of the metatarsus and tarsus of the second legs.

FEMALE: Total length of body, 2.8 mm. Cephalothorax, 0.9 mm. Width of body at widest portion, 1.9 mm.

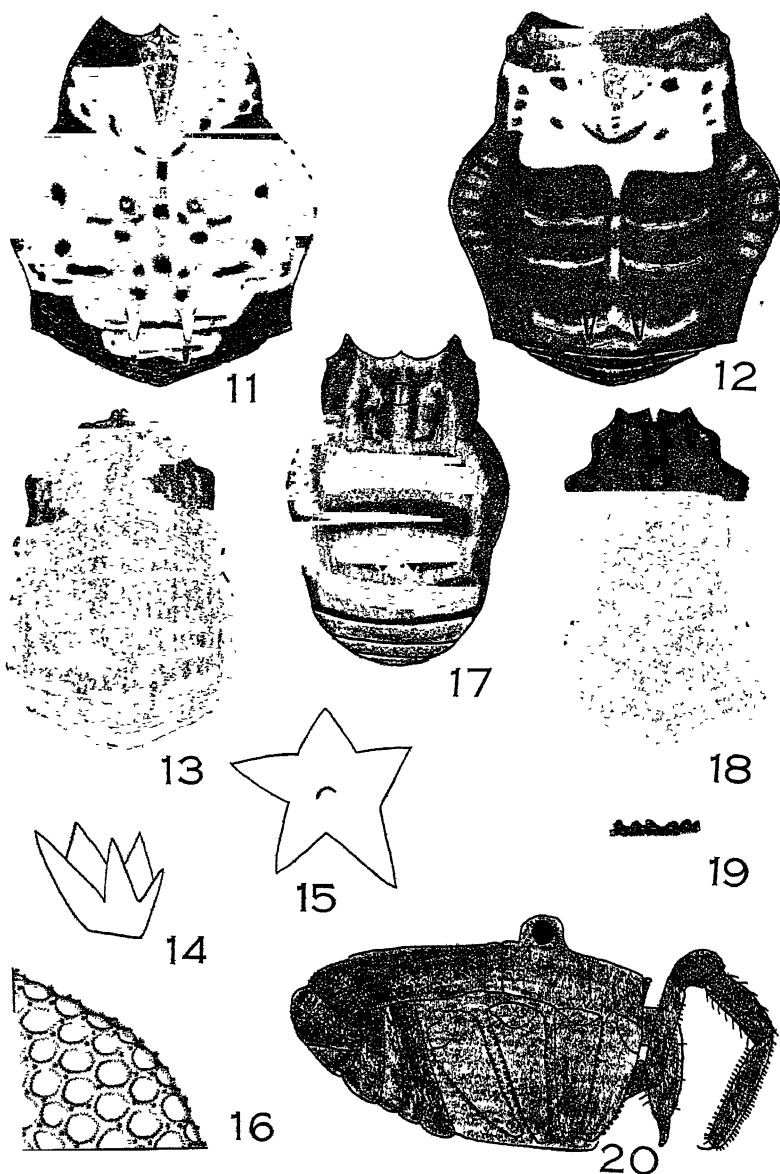
Identical in appearance with the male.

TYPE LOCALITY: Male holotype and male and female paratypes from Finca La Victoria, Montozintla, Chiapas, January 18, 1945 (T. C. Schneirla).

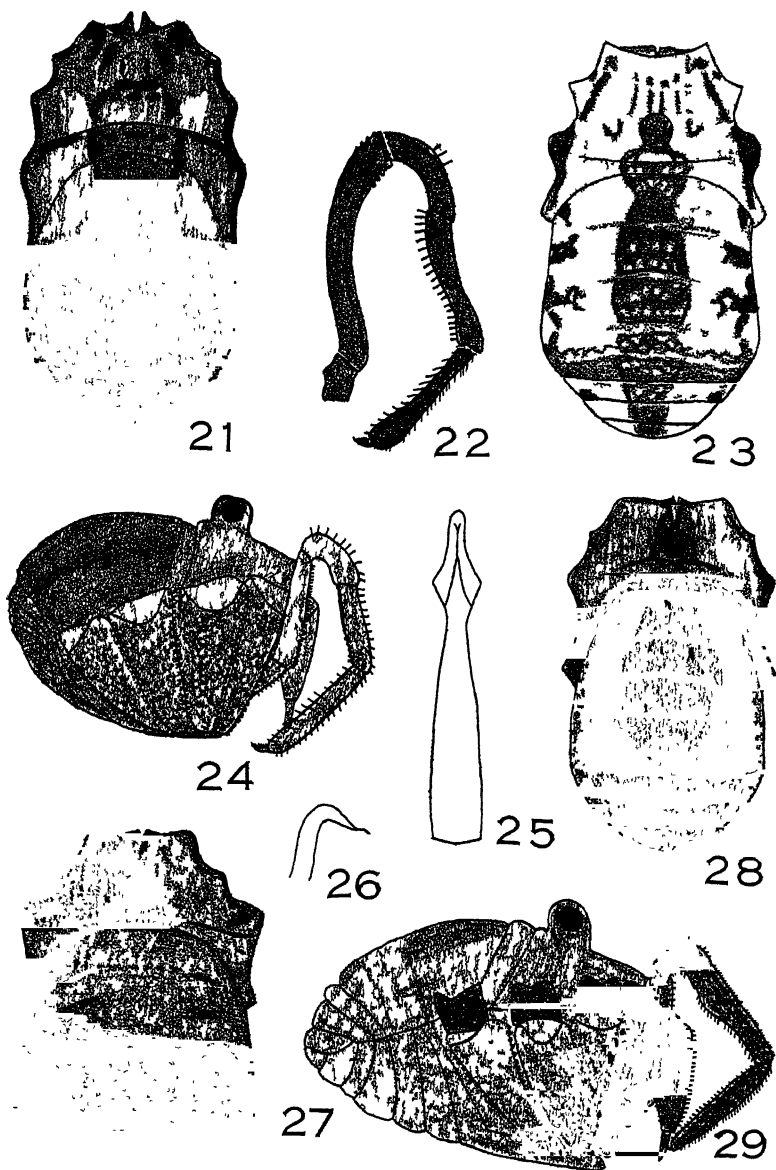
This species differs from other members of the genus *Prionostemma* by having a pitted dorsum and a distinctive color pattern.



- Fig. 1. *Kevonones mexicanus* (Banks), dorsal view of male.
 Fig. 2. *Poala mexicana* (Banks), dorsal view of femur of fourth leg of female.
 Fig. 3. Idem, dorsal view of female. Portion enclosed by dotted line missing in the holotype.
 Fig. 4. *Prionostemma victoriae*, new species, lateral view of male.
 Fig. 5. Idem, lateral view of teeth of the coxae.
 Fig. 6. *Chapulobunus unispinosus*, new species, retrolateral view of palpus of female.
 Fig. 7. Idem, dorsal view of female.
 Fig. 8. Idem, dorsal view of trochanter and femur of left fourth leg of female.
 Fig. 9. Idem, lateral view of eye tubercle of female.
 Fig. 10. *Krusa tuberculata*, new species, lateral view of male.



- Fig. 11. *Cynortoides albiadpersus*, new species, dorsal view of male.
 Fig. 12. *Cynortia formosa*, new species, dorsal view of male.
 Fig. 13. *Krusa stellata*, new species, dorsal view of male.
 Fig. 14. Idem, lateral view of one of the small teeth present on the dorsum.
 Fig. 15. Idem, dorsal view of one of the small teeth present on the dorsum.
 Fig. 16. Idem, view of a section of the dorsum, showing the ridges and the position of the small teeth.
 Fig. 17. *Parasonones schneirlai*, new species, dorsal view of female.
 Fig. 18. *Krusa metallica*, new species, dorsal view of female.
 Fig. 19. *Cosmobunus auratus*, new species, lateral view of the teeth of the coxae.
 Fig. 20. Idem, lateral view of male.



- Fig 21 *Lerobunum escondidum* Chamberlin dorsal view of male
 Fig 22 *Lerobunum denticulatum* Banks lateral view of palpus of male
 Fig 23 Idem dorsal view of male
 Fig 24 *Pronostemma lubeca* new species lateral view of male
 Fig 25 *Krusa flava* new species dorsal view of penis of male
 Fig 26 Idem lateral view of tip of penis of male
 Fig 27 Idem dorsal view of male
 Fig 28 *Lerobunum guerreroensis* new species dorsal view of male
 Fig 29 *Lerobunum royak*, new species lateral view of female

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A NEW PLIOCENE ALLIGATOR FROM NEBRASKA

BY CHARLES C. MOOK¹

In the summer of 1941 a well-preserved skull and jaws, with some postcranial bones, of an alligator were found by Mr. Ralph Mefferd, of the Frick Laboratories of the American Museum of Natural History. The specimen was found on the George Sawyer Ranch in Cherry County, Nebraska, S.E. $\frac{1}{4}$ Sect. 5, T. 31 N., R. 30 W. It occurred in a series of fresh-water marls and sandy channel deposits at about the middle of the Ash Hollow formation. These deposits rest unconformably upon the basal member of the Ash Hollow of this area, referred to in the field as the "Cap Rock" because of its erosion-resisting ability.

No associated fauna was found with the specimen, although the University of Nebraska collected the type of *Torynobelodon barnumbrowni* from the same deposits less than a quarter of a mile north on the west side of the river.

The appended generalized stratigraphic section illustrates the relationship of these two specimens to the stratigraphic members of the area.

I wish to acknowledge my indebtedness to Mr. Childs Frick for permission to describe this fine specimen, and to Mr. Morris F. Skinner, of the Frick Laboratories, for calling my attention to the specimen and for information regarding its occurrence.

Alligator mefferdi, new species

Named in honor of the discoverer of the type, Mr. Ralph Mefferd.

TYPE: A well-preserved skull with jaws, the arch and spine of a vertebra, several scutes, and a hyoidean bone, F.A.M.N.H. No. 7016.

CHARACTERS: The characters of the genus *Alligator*; external narial aperture broader in proportion to its length than in *A. mississippiensis*, and its anterior portion is nearer the tip of the snout; the lateral margins of this aperture are distinctly elevated above the surrounding skull surface, contrasting with the condition in *A. mississippiensis* and *A. thomsoni*. The superficial channeling of the snout is more pronounced than in any other known alligator. A depression between the anterior portions of the orbits is deeper than in any other alligator and resembles the condition present in the South American caimans.

The premaxillary foramen on the palate is oval instead of pear-shaped as in *A. mississippiensis* and *A. thomsoni*. The palatine fenestrae are more regularly oval than in the two species just mentioned, and their long axes are more nearly parallel with the long axis of the skull.

TYPE LOCALITY AND LEVEL: Cherry County, Nebraska, George Sawyer Ranch; S.E. $\frac{1}{4}$ Sect. 5, T. 31 N., R. 30 W.; upper portion of Ash Hollow formation, Middle Pliocene.

DESCRIPTION OF TYPE MATERIAL

The general form of the skull is similar to that of *Alligator mississippiensis* and *A. sinense*. The external narial aperture is slightly broader in proportion to its

length than in *A. mississippiensis*. The anterior border of the aperture is nearer the tip of the snout, the anterior bar of the premaxillaries being somewhat more slender. The lateral margins of the aperture, especially in their posterior portions, are

¹ Contributions to the Osteology, Affinities, and Distribution of the Crocodilia. No. 40.

very distinctly elevated above the surrounding areas, much more so than in *A. mississippiensis*, *A. sinense*, or *A. thomsoni*. In this character the species resembles *A. mcgrewi*, from the Nebraska Miocene. The median septum of the aperture is of the usual alligatorid form.

The degree of vertical festooning of the snout is less than in *A. sinense*, while the channeling of the snout is more pronounced than in any other species of *Alligator*. The sutures between the premaxillaries and the nasals are more oblique than in *A. mississippiensis*. The usual alligatorid relations of nasals, prefrontals, and lacrimals, the lacrimals being shut out of contact with the nasals by the anterior extensions of the prefrontals, are definitely present.

The orbits are relatively longer in proportion to their breadth than in *A. sinense*. The inner borders of the orbits are strongly enrolled toward the midline of the skull along the entire length of the orbits, making two prominent ridges. These ridges almost meet each other near the central points of the orbits and then diverge in the anterior direction, partially enclosing a triangular depressed area between the anterior portions of the orbits. This depressed area is comparable to the similar, but posteriorly rounded, depression at the base of the snout in *Caiman crocodilus*. The ridges extend forward on the snout, anterior to the front ends of the orbits, much as in *Crocodylus porosus*. External to these ridges, and parallel with them, are fore and aft depressions, chiefly on the maxillaries, but also partially on the lacrimals.

The anterior part of the snout is distinctly pitted, the posterior part only slightly so, agreeing closely with the condition in *A. mississippiensis*.

The interorbital plate is relatively broader than in the Florida alligator, but is relatively narrower than in *A. thomsoni* and *A. sinense*. The lower postorbital bar, composed of elements of jugal and postorbital bones, is relatively stouter than in *A. mississippiensis*; the lateral temporal fenestrae are similar to those of the latter species.

The supratemporal fenestrae are similar

to those of *A. mississippiensis*, but the interfenestral plate is slightly broader, relatively, and its edges are uprolled more. The supraoccipital bone is shorter and broader than in the Florida alligator and as in that species does not appear on the superior surface of the skull. On the palate the characters of the premaxillary foramen are obscured somewhat by distortion, but the portions of its boundaries that are preserved indicate that it was oval rather than pear-shaped as in *A. mississippiensis* and *A. thomsoni*. It is relatively larger than in *A. sinense*.

The palatine fenestrae are long and narrow. They are longer in proportion to their breadth than in *A. sinense*. They appear to be more regularly oval than in *A. mississippiensis* and *A. thomsoni*. Their long axes are more nearly parallel with the long axis of the skull than in those species. The internal narial aperture is relatively large; its postero-external borders are elevated into distinct ridges.

The posterior processes of the premaxillaries are less acute than in *A. sinense*. Each premaxillary bone contains five alveoli. Of these the first and second are very small, the fifth is slightly larger than these, the third is substantially larger than the fifth, and the fourth is much larger than the third; the fourth is also equal in size to, if not larger than, the fourth maxillary alveolus.

This is in contrast with the condition in *A. mississippiensis*, in which the third and fourth premaxillary alveoli are approximately equal in size; it is in agreement, however, with the condition in *A. thomsoni*. The fourth premaxillary tooth of the left side is preserved. It agrees in characters with the corresponding tooth of *A. thomsoni*, being short and stout; it is shorter than the fourth premaxillary tooth of *A. mississippiensis*.

The short maxillo-nasal sutures resemble those of *A. sinense*. There appear to be 14 alveoli in each maxillary. These increase in size regularly from the first, which is very small, to the fourth, which is the largest in the skull. These four are closely spaced as in most alligators. The fifth is equal in size to the second and is distinctly separated

from the fourth. The sixth, seventh, and eighth alveoli are small and are close together, although they are not confluent. Posterior to the eighth the alveoli are of moderate size and are essentially confluent with each other. The ninth, tenth, and eleventh teeth of the right maxillary are preserved, also all of the teeth of the left maxillary except the ninth and the fourteenth. The first maxillary tooth is very small. It is slender in proportion to its height. It is rather bluntly curved and it appears to bend rather abruptly inward near the tip; it is faintly bladed on its anterior and posterior edges. The second tooth is distinctly larger than the first, and its crown is somewhat triangular in shape. It is comparatively thin and is distinctly bladed on its anterior and posterior margins; it is sharp, is slightly curved inward, and exhibits very faint striations.

The third maxillary tooth resembles the second in most characters except that it is much larger; its striations are less distinct—in fact they are scarcely distinguishable. The surface of the crown near the tip is slightly roughened. The blades are very distinct, the anterior blade being particularly so; the constriction near the anterior edge to form the blade is great enough to produce a distinct groove on the antero-internal surface of the tooth. The large fourth tooth bears a distinct resemblance to the third except that it is much larger. The groove setting off the anterior blade from the internal surface is somewhat more conspicuous. This tooth, which is definitely the largest in the series, is less rounded in cross section than the corresponding tooth in *A. mississippiensis*.

The fifth tooth, present on the left side, is an immature tooth that had recently replaced a predecessor, and only the tip is visible. It resembles the second somewhat in size and characters, but is slightly more stoutly constructed, and is more distinctly striated. The sixth maxillary tooth is small and blade-like; it is distinctly striated and its lateral dimension is very small. The seventh maxillary tooth resembles the sixth in all essential characters. The eighth is not preserved on either side of the specimen. The ninth, tenth, and eleventh are

present on both sides, and the twelfth and thirteenth are present on the left side only. These teeth are all much larger than the sixth and seventh. They are all short-crowned and flattened; they are blunter than the teeth farther forward, and do not curve inward as the latter do. The ninth is of medium size, the tenth is quite large, more or less equaling the third maxillary tooth in size, and is distinctly exceeded in size only by the fourth. The eleventh, twelfth, and thirteenth maxillary teeth are small, close together, and subequal in size. The fourteenth is not preserved on either side.

The nasal bones extend backward beyond the level of the anterior borders of the orbits. They are separated from each other at their posterior ends by the anterior process of the frontal. They differ in this respect from *A. sinense* and *A. mississippiensis*. The frontal bone is excluded from participation in the anterior borders of the supratemporal fenestrae by a narrow transverse bar of the parietal as in other species of *Alligator*.

The left ramus of the lower jaw is complete, and the right ramus is nearly so. The symphysis extends back to the level of the fifth mandibular teeth. The portion of the jaw posterior to the tooth row is slightly shorter than the tooth row itself. The post-articular process is short. The splenials appear not to reach the symphysis. The extent of festooning of the jaw margins is slight. The external mandibular fenestrae are large.

There were apparently 21 teeth in each ramus. These were arranged in the order of position with respect to size and shape as follows: The first is large, acuminate, distinctly curved inward, and is distinctly bladed on its anterior and posterior edges. The second and third are of moderate size. These teeth are considerably shorter than the first, and the anterior and posterior blades are much less conspicuous. The fourth is the largest tooth in the lower jaw. It is elongate, compressed oval in section, with anterior and posterior blades. All of these teeth are spaced moderately far apart from each other; the fourth is moderately far from the fifth.

TABLE 1

MEASUREMENTS OF *Alligator mefferdi*, NEW SPECIES, F.A.M.N.H. No. 7016
(Measurements in millimeters)

Length of skull, tip of snout to supraoccipital.....	287
Length of skull, tip of snout to occipital condyle.....	298
Length of snout.....	171
Length of right orbit.....	63
Length of left orbit.....	63
Length of external narial aperture.....	34
Length of left supratemporal fenestra.....	22
Length of cranial table.....	57
Breadth of skull across premaxillary-maxillary suture at sides.....	93
Breadth at fourth maxillary teeth.....	123
Breadth of snout at base.....	135
Breadth of interorbital plate.....	27
Breadth of right orbit.....	38
Breadth of left orbit.....	41
Breadth of left supratemporal fenestra.....	29
Breadth of skull across quadrates (estimated from one side).....	170
Breadth of interfenestral plate.....	10
Breadth of cranial table, anterior end (estimated from one side).....	85
Breadth of cranial table, posterior end (estimated from one side).....	86
Breadth of parietal bone along posterior border of cranial table.....	34
Length of palate, tip of snout to anterior ends of palatine fenestrae.....	134
Length of maxillaries, midline of palate.....	77
Length of palatine, midline.....	94 est.
Length of premaxillary fenestrae.....	27
Length of left palatine fenestra, estimated.....	68
Length of left tooth row (distorted).....	198
Length of right tooth row (distorted).....	200
Length of interfenestral plate between palatine fenestrae.....	35
Length of pterygoid along midline.....	45
Length of internal narial aperture.....	23
Breadth of internal narial aperture.....	15
Breadth of pterygoids.....	123
Length of left ramus of mandible, complete.....	360
Length of left mandibular tooth row.....	176
Length of mandibular symphysis.....	40
Length of external mandibular foramen.....	67
Height of left ramus at external mandibular foramen.....	34
Height of left ramus, maximum.....	67
Breadth of symphysis, maximum.....	71
Breadth of left articular surface.....	37
Length of crown of left fourth maxillary tooth.....	17
Anteroposterior diameter of left fourth maxillary tooth.....	10
Transverse diameter of left fourth maxillary tooth.....	8
Length of crown of left tenth maxillary tooth.....	10
Anteroposterior diameter of left tenth maxillary tooth.....	10
Transverse diameter of left tenth maxillary tooth.....	7
Length of crown of left first mandibular tooth.....	15 est.
Anteroposterior diameter of left first mandibular tooth.....	9
Transverse diameter of left first mandibular tooth.....	6
Length of crown of left fourth mandibular tooth.....	16 est.
Anteroposterior diameter of left fourth mandibular tooth.....	10
Transverse diameter of left fourth mandibular tooth.....	7
Length of crown of right fourth mandibular tooth.....	18
Anteroposterior diameter of right fourth mandibular tooth.....	10
Transverse diameter of left thirteenth mandibular tooth.....	7
Breadth across diapophyses of an anterior dorsal vertebra.....	77
Breadth across prezygapophyses of same.....	40
Breadth across postzygapophyses of same.....	42 est.
Height of spine above neural arch-centrum suture.....	68

The fifth to the eleventh teeth, inclusive, are small; their crowns are triangular and flattened; they are close together, but their alveoli are not confluent. The twelfth, thirteenth, and fourteenth teeth are large, the thirteenth approaching the fourth in size. These teeth have crowns of only moderate height, but their anteroposterior

dimensions are great so that their external surfaces are large. Posterior to the fourteenth the teeth are all low crowned, flat, with their crowns longer anteroposteriorly than they are high. They become progressively lower and blunter in the posterior direction. The alveoli of these teeth are confluent.

TABLE 2

	RATIOS				
	<i>A. mefferdi</i> F:A.M.N.H. No. 7016	<i>A. thomsoni</i> A.M.N.H. No. 1736	<i>A. mississippiensis</i> A.M.N.H. No. 9043	<i>A. sinense</i> A.M.N.H. No. 23892	<i>A. sinense</i> A.M.N.H. No. 7122
Length of snout					
Length of skull, tip of snout to supraoccipital	0.595	0.540	0.636	0.549	0.640
Length of snout					
Length of skull, tip of snout to occipital condyle	0.577	0.530	0.630	0.539	0.630
Breadth of snout at base					
Length of snout	0.800	0.988	0.682	0.831	0.780

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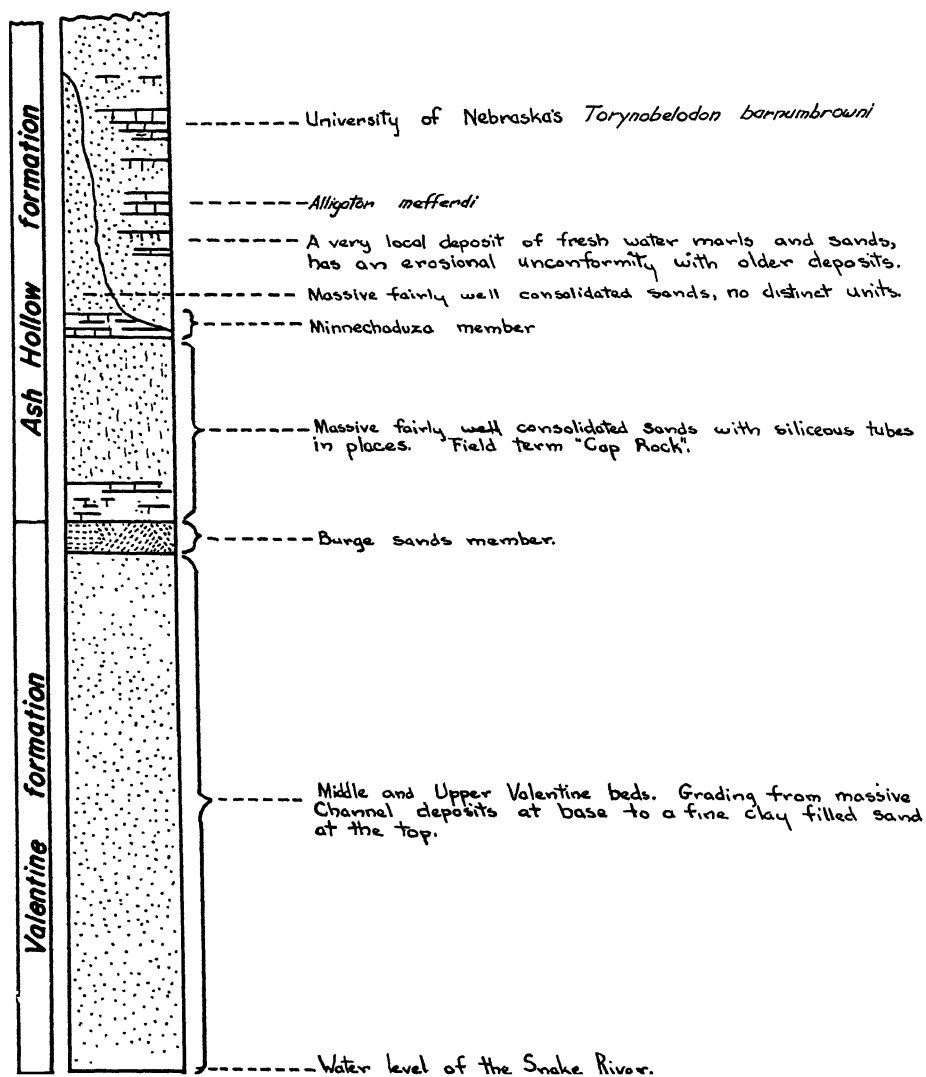


Fig. 1. Stratigraphic column at type locality, Cherry County, Nebraska. Data furnished by Mr. Morris F. Skinner.



Fig 2 *Alligator mcferri*, new species Type, F A M N H No 7016 Skull superior view, one-half natural size



Fig. 3. *Alligator mefferdi*, new species. Type, F.A.M.N.H. No. 7016. Skull, inferior view, one-half natural size.



Fig 4 *Alligator mefferdi*, new species Type I A M N H No 7016 Skull and jaws lateral view left side one half natural size



Fig. 5. *Alligator mefferdi*, new species. Type, F.A.M.N.H. No. 7016. Lower jaws, superior view, one-half natural size.

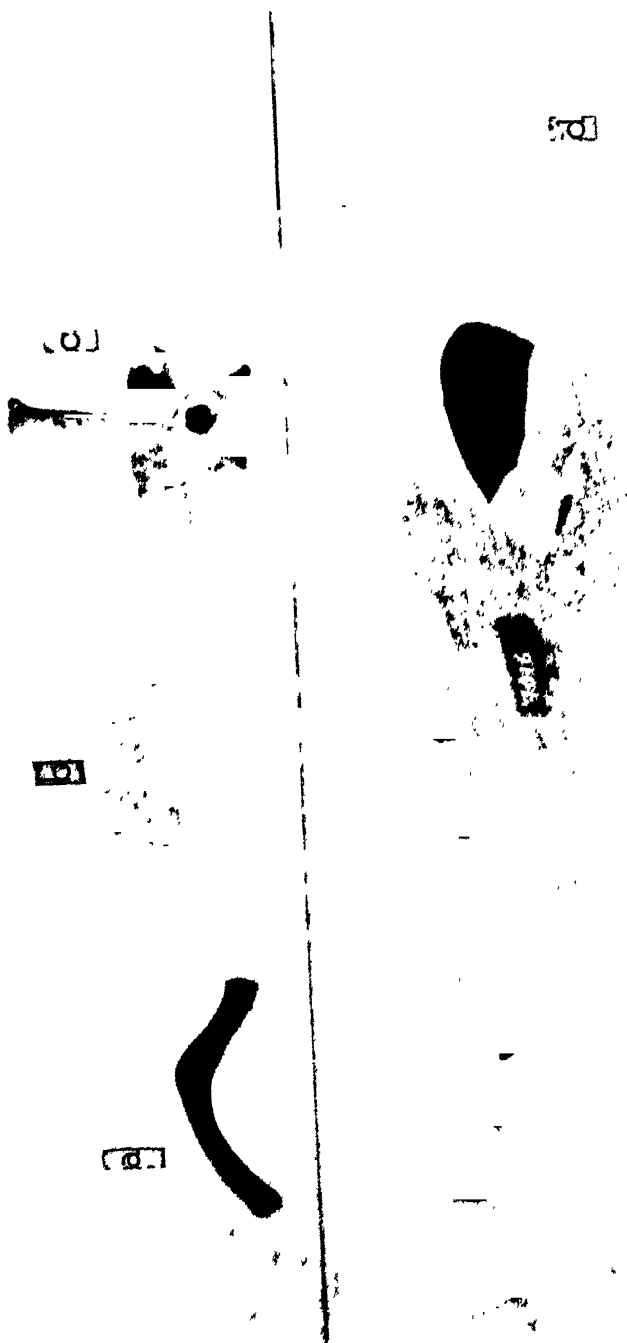


Fig 6. *Alligator mefferdi*, new species. Type, F.A.M.N.H. No. 7016. a, Hyoid element, b, nuchal scute; c, arch and spine of a dorsal vertebra, d, left ramus of mandible, external view, all figures one-half natural size.

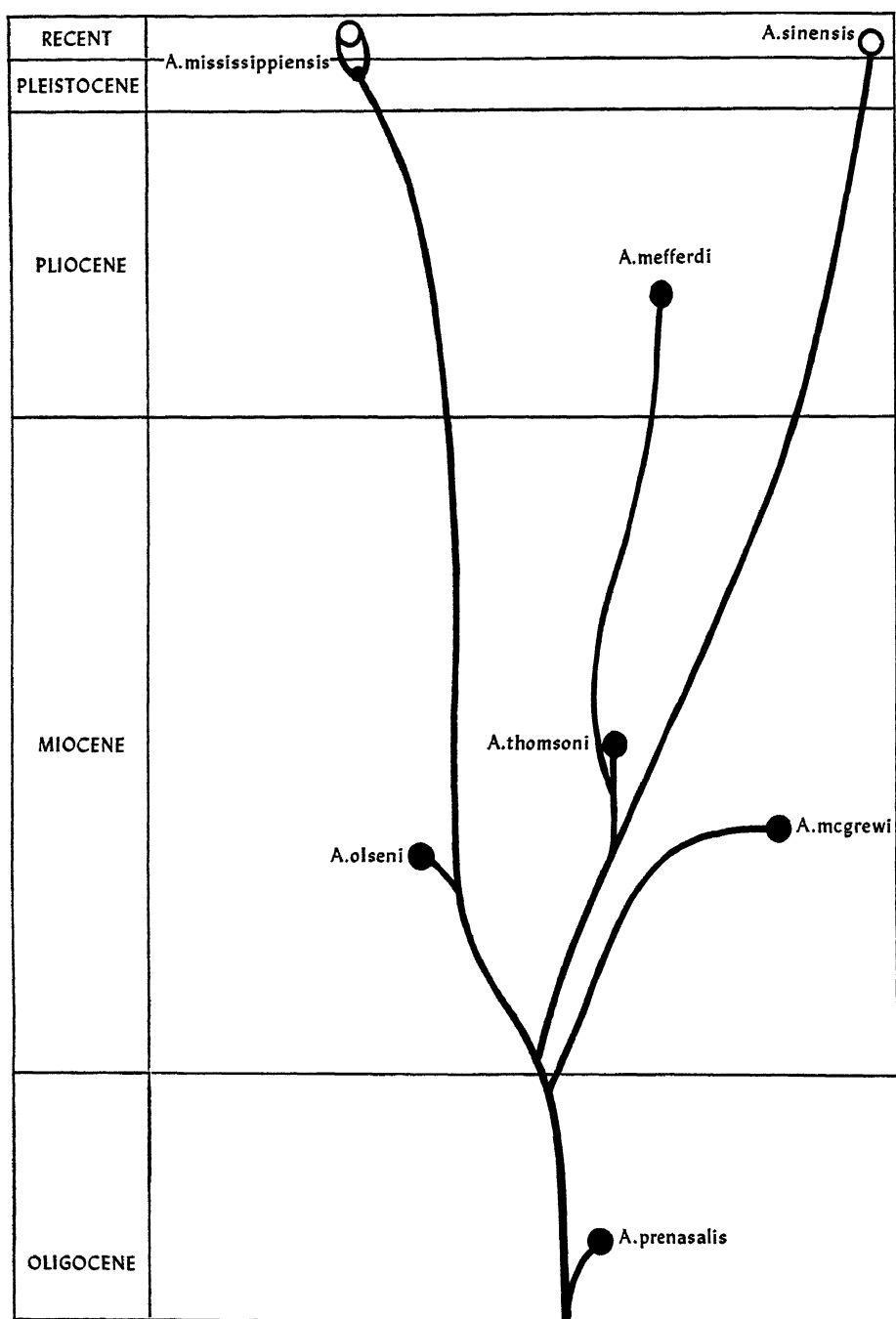


Fig. 7. Interpretation of the phylogenetic relations of species of the genus *Alligator*.

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TWENTY-THREE NEW SUBSPECIES OF BIRDS FROM VENEZUELA AND BRAZIL¹

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The study of new material in the Phelps Collection, Caracas, Venezuela, has revealed a number of new subspecies which are described in this paper.

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In the lists of specimens examined, those in the Phelps Collection are so characterized; the remaining material is in the American Museum of Natural History.

Names of colors are capitalized when direct comparison has been made with Ridgway's "Color standards and color nomenclature."

Pyrrhura egregia obscura, new subspecies

TYPE: From Mt. Auyan-tepui, State of Bolívar, Venezuela; altitude 1100 meters. No. 324138, American Museum of Natural History. Adult male collected February 6, 1938, by E. T. Gilliard (Phelps Venezuelan Expedition).

DIAGNOSIS: Similar to *P. e. egregia* of western British Guiana and the Mt. Roraima region of Venezuela but upper parts darker green and lower parts slightly darker green.

RANGE: Known only from the Subtropical Zone on Mt. Auyan-tepui, at an altitude of 1100 meters, and on Mt. Ptari-tepui, 120 kilometers to the east, at altitudes from 1300 to 1800 meters.

¹ Previous papers by the same authors, describing new birds in the Phelps Collection, are "New species and subspecies of birds from Venezuela. 1" (1944, Amer. Mus. Novitates, no. 1270), and "New species and subspecies of birds from Venezuela. 2" (1945, Amer. Mus. Novitates, no. 1274).

DESCRIPTION OF TYPE: Two millimeters of forehead nearest to the bill Bay; crown dark Forest Green, uniform with the back, with the centers of the feathers Mars Brown, giving a blotched appearance to the head; back and uropygium dark Forest Green, brighter on the upper tail-coverts; a bare ring about the eye; sides of head Bice Green. Throat and breast somewhat duller green than the back, with a fine terminal dusky border on the feathers preceded by a broader band of buffy, giving a scaled appearance; abdomen, sides, and under tail-coverts Bice Green; some scarlet feathers on the sides under the wings and on the lower shanks. Upper wing-coverts, tertiaries, and upper aspect of secondaries uniform with the back; outer primary dusky; upper aspect of other primaries Plum Purple with Dull Violet-Blue edgings and with dusky inner vanes; shoulder Scarlet-Red merging into the Cadmium Yellow of the bend of the wing; under aspect of remiges Olivaceous-Black; under wing-coverts largely Cadmium Yellow with a suffusion of Scarlet-Red at shoulder and bend of wing. Upper aspect of tail Hay's Maroon with a tinge of green at the base of the outer webs; lower aspect Fuscous. Bill (in dried skin) flesh; feet dusky. Wing, 125 mm.; tail, 116; culmen from cere, 17; tarsus, 14.5.

REMARKS: Sexes alike. Size similar to *P. e. egregia*. Range of measurements: five adult males: wing, 125-129 (127) mm.; tail, 115-117 (116); culmen from cere, 15.5-18 (16.5); tarsus, 13-14.5 (14); three adult females: wing, 123-127 (125.5); tail, 98-113 (107); culmen from cere, 15.5-16.5 (16); tarsus, 14-14.5 (14).

Labels on the specimens other than the

type show that in life the bare skin about the eye is white, the iris brown, and the feet brownish black. Most of the specimens of *P. e. egregia* have indications of brownish feathers (tipped with green) in the center of the abdomen, forming at times a patch. In *P. e. obscura* this is less frequently, and usually less prominently, developed.

SPECIMENS EXAMINED

P. e. egregia.—BRITISH GUIANA: Minnehaha Creek, 1 ♂; Kamarang River, 1 ♀; (Phelps Collection): Paruima Mission, Kamarang River, 6 ♂, 2 ♀. VENEZUELA: Roraima, 2 ♂, 3 ♀; Arabupú, near Mt. Roraima, 1 ♂, 2 ♀; (Phelps Collection): Arabupú, 1 ♂.

P. e. obscura.—VENEZUELA: Mt. Auyan-

tepuí, 2 ♂ (including type), 1 ♀; (Phelps Collection): Mt. Auyan-tepuí, 1 ♀; Mt. Ptari-tepuí, 3 ♂, 1 ♀.

Trogon personatus ptaritepuí,
new subspecies

TYPE: From Kabanayén, near Mt. Ptari-tepuí, Gran Sabana, State of Bolívar, Venezuela; altitude 1200 meters. No. 24236, Phelps Collection, Caracas. Adult female collected February 12, 1944, by William H. Phelps. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Similar to *T. p. roraimae* except that in the female the pectoral band

78	Kabanayén	58	Quebrada Candelarita, Bolívar
20	La Florida	20	Quebrada Seca, Sucre
26	La Fría	29	Queniquea
97	La Laja	48	Quiribana de Caicara
70	La Paragua	84	Raudal Capurí, Caño Anatabari
53	La Prisión	85	Raudal Caranca, Río Carún
1	La Sabana	21	Rincón de San Antonio
2	La Sierra	89	Río Arawa
20	La Tigra	78	Río Caruái
53	La Unión	55	Río Caura
40	La Veguita	88	Río Chanaro (mouth)
60	Las Barrancas	18	Río Neverí
10	Las Quiguas	54	Río Nichare
10	Las Trincheras	94	Río Ocamo (mouth)
18	Latal (La Latal)	80	Roraima (Mt. Roraima)
96	Laterite Valley	90	Sabana Canaracuni
13	Loma Redonda	97	Sabana Grande
17	Los Altos	90	Sabana Kirichú
14	Los Caracas	84	Salto El Payaso, Caño Antabari
20	Los Dos Ríos	74	Salto Guaiquinima
20	Los Palmales	87	Salto Maiza
23	Los Testigos Is.	86	Salto María Espuma
62	Manoa	72	Salto Uraima
16	Margarita I.	21	San Antonio
52	Maripa	9	San Esteban
34	Mérida	66	San Felipe (Hato), Tumeremo
83	Mt. Auyan-tepuí	59	San Félix, Bolívar
4	Mt. Bucarito (near)	20	San Félix, Cumanacoa
96	Mt. Duida	102	San Fernando de Atabapo
97	Mt. Duida (foot of)	5	San Luis
75	Mt. Guaiquinima	104	Sanariapo
76	Mt. Ptari-tepuí	20	Santa Ana Valley
80	Mt. Roraima	38	Santa Bárbara, Barinas
93	Mt. Sarisariñama	82	Santa Elena, Bolívar
77	Mt. Sororopán-tepuí	50	Santa Rosalía, Bolívar
73	Mt. Tonoro	35	Santo Domingo, Mérida
103	Nericagua	30	Santo Domingo, Táchira
54	Nichare River	28	Seboruco
45	Palenque	101	Solano
34	Páramo del Mono, Mérida	51	Suapure
81	Paulo	96	Summit Camp, Mt. Duida
105	Perico (Puerto Ayacucho)	34	Tabay
80	Philipp Camp, Mt. Roraima	15	Tortuga I.
61	Piacoa	7	Tucacas
95	Pie del Cerro, Duida	67	Tumeremo
97	Playa del Río Base	72	Uraima Falls
105	Puerto Ayacucho	33	Valle (El Valle)
9	Puerto Cabello	95	Valle de los Monos
11	Puerto de la Cruz, D. F.	24	Yaguapaparo
21	Quebrada Bonita	64	Yuruari River

is paler, with a more olivaceous tinge, less rich brownish.

RANGE: Known only from Mt. Ptari-tepui at altitudes from 1200 to 1800 meters and from Kabanayén, near the base of that mountain, at an altitude of 1200 meters.

DESCRIPTION OF TYPE: Crown and nape Brussels Brown; back Medal Bronze merging into the Brussels Brown of the upper tail-coverts. Lores and a broad ring around the eye, ear-coverts, cheeks, chin, and throat black; a prominent, wide, postocular, semicircular lunule of white immediately behind the eye; a wide pectoral band, near Dresden Brown, with a narrow white one below it; abdomen, flanks, and under tail-coverts between Scarlet and Rose Doree; thighs dusky. Wings Fuscous-Black, the primaries, except the outermost, narrowly edged with white on the outer vanes; outer vanes of secondaries, tertials, and lesser wing-coverts finely speckled with grayish olive, the coverts at the shoulder merely edged with olive; under wing-coverts fuscous gray, the smaller feathers with slight olivaceous tips. Median rectrices and outer vanes of the adjoining two pairs approaching Auburn, with a black terminal band; inner webs of two submedian pairs black with a fine inner border of Auburn; outer three pairs black with a broad white tip and with the outer web and the subterminal portion of the inner web narrowly barred with black and white. Bill (in life) "yellow"; feet "yellow"; iris "dark." Wing, 124 mm.; tail, 122; culmen from base, 20.5; tarsus, 14.

REMARKS: Description of adult male (No. 24063, Phelps Collection, collected by Kathleen D. Phelps): Forehead, lores, broad circumocular ring, side of head, chin, and throat black; crown, nape, breast, and upper tail-coverts dark Hay's Green with a golden metallic sheen; back shiny metallic golden bronze. White band separating the green of the breast from the Scarlet-Red of the abdomen, flanks, and under tail-coverts; thighs black. Wings black; primaries, except the outermost, narrowly edged with white on the outer vanes; outer vanes of secondaries, tertials, and lesser wing-coverts finely speckled with white, coarser and forming vermicu-

lated bars towards the shoulder; scapulars shiny green, uniform with the back. Median rectrices and outer webs of the following two pairs shiny metallic Medal Bronze with a black terminal band; inner webs of two submedian pairs black; outer three pairs as described for the female. Bill (in life) "yellow"; feet "yellow"; iris "brownish-yellow"; eyelid "yellow." Wing, 123 mm.; tail, 134; culmen from base, 20; tarsus, 14.5. In the series, the color of the breast varies from the light green of the specimen described above to dark bluish green.

REMARKS: Size similar to *T. p. roraimae*. Range of measurements: five adult males: wings, 118-124 (121) mm.; tail, 128-134 (132); culmen from base, 18.5-21 (19.5); tarsus, 14-14.5; four females: wing, 114-124 (118.5); tail, 120-126 (122); culmen from base, 18.5-20.5 (20); tarsus, 13-15 (14).

SPECIMENS EXAMINED

T. p. personatus.—VENEZUELA: Mérida region, 18 ♂, 15 ♀; Colonia Tovar, 3 ♂. COLOMBIA: Santa Marta region, 6 ♂, 7 ♀; Bogotá region, 6 ♂, 1 ♀; El Eden, 1 ♂, 1 ♀; Gallera, 1 ♀; Santa Elena, 1 ♀; Cocal, 1 ♂; Choachi, 1 ♀. ECUADOR: Baeza, 2 ♂, 1 ♀; Ambato, 1 ♂, 1 ♀; Papallacta, 3 ♂; Río Pastaza, 1 ♂, 1 ♀. PERÚ: Leimebamba, 1 ♂; Maraynioc, 1 ♂, 1 ♀; Carabaya, 1 ♂. BOLIVIA: Piti-guaya, 1 ♂; Incachaca, 1 ♂, 1 ♀; Roquefalta, 1 ♂.

T. p. assimilis.—ECUADOR: Gualea, 1 ♂, 1 ♀; El Chiral, 1 ♂, 2 ♀; Zaruma, 1 ♀.

T. p. duidae.—VENEZUELA: Mt. Duida, 4 ♂, 1 ♀.

T. p. roraimae.—VENEZUELA: Mt. Roraima, 4 ♂, 1 ♀; Mt. Auyan-tepui, 1 ♂, 1 ♀; (Phelps Collection): Mt. Roraima, 1 ♂; Arabupú, near Mt. Roraima, 2 ♂, 2 ♀; Mt. Guaiquina, 3 ♂, 4 ♀.

T. p. ptari-tepui.—VENEZUELA (Phelps Collection): Mt. Ptari-tepui, 6 ♂, 2 ♀ (including type); Kabanayén, near Mt. Ptari-tepui, 3 ♂, 2 ♀.

Polemistria pavonina punctigula, new subspecies

TYPE: From Mt. Ptari-tepui, Misia Kathy Camp, Gran Sabana, State of Bolívar, Venezuela; altitude 1350 meters. No. 26957, Phelps Collection, Caracas. Adult [? female], not sexed, collected August 8, 1944, by Fulvio Benedetti.

(Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: The female differs from *P. p. pavonina* and *P. p. duidae* by having the pale markings on the chin and throat finer and purer white and the dark margins of the feathers less obvious on the chin which thus appears more uniformly white; tips of outer rectrices also purer white. The male is unknown.

RANGE: Known only from the southwestern slope of Mt. Ptari-tepui at altitudes of 1360 and 1600 meters.

DESCRIPTION OF TYPE: Top of head and back Spinach Green with a metallic golden sheen; an indication of a faint bronzy streak in the center of the crown and forehead; ear-coverts bronzy green; a narrow buffy white band across the anterior rump; posterior rump and upper tail-coverts bronzy. Feathers of chin and throat pure white (some feathers stained with rusty) with dusky edges giving a speckled rather than striped appearance; feathers at side of throat elongated; breast and most of abdomen grayish brown; lower abdomen white; sides and flanks green, more golden than the back; under tail-coverts grayish bronze. Remiges, greater upper wing-coverts, and primary coverts Dark Livid Purple, with median and lesser coverts green, uniform with the back; under wing-coverts green. Tail greenish bronzy, darker toward tip; the rectrices, except the median pair, with white at the tips forming terminal spots on the two outer pairs and a fringe, only, on the others. Bill (in life) "black"; feet "black"; iris "dark." Wing, 42 mm.; tail, 22; exposed culmen, 10; culmen from base, 14.5; tarsus, 6.

REMARKS: No males were collected. Measurements of the second specimen, an adult female, are: wing, 43 mm.; tail, 22; exposed culmen, 9; culmen from base, 13.5.

On Mt. Guaiquinima two males were collected which are similar to *P. p. duidae* from Mt. Duida, but no females. On Mt. Auyan-tepui the species was not encountered.

The non-sexed specimen was used as the type because the sexed one is a poor skin.

They are similar. The males of this species have a quite different plumage.

SPECIMENS EXAMINED

P. p. pavonina.—VENEZUELA: Roraima, 7 ♂, 4 ♂ juv., 2 ♀. BRITISH GUIANA: Kamarang River, 1 ♂; "British Guiana," 1 ♂ juv.

P. p. duidae.—VENEZUELA: Mt. Duida, 1 ♂ (type), 2 ♀; (Phelps Collection): Mt. Guaiquinima, 2 ♂.

P. p. punctigula.—VENEZUELA (Phelps Collection): Mt. Ptari-tepui, 1 ♀, 1 [♀] (type).

Campylopterus duidae guaiquinimae, new subspecies

TYPE: From Mt. Guaiquinima, Paragua River, State of Bolívar, Venezuela; altitude 1500 meters. No. 28725, Phelps Collection, Caracas. Adult male collected February 4, 1945, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Differs from *C. d. duidae* in having the under parts darker, more rufescent buff instead of paler grayish buffy, and the terminal portion of the tail similarly darker. It is smaller, with the wing and bill 10 per cent shorter and the tail 13 per cent shorter than in the allied form.

RANGE: Known only from the summit and northwestern slope of Mt. Guaiquinima at altitudes from 1220 to 1700 meters.

DESCRIPTION OF TYPE: Forehead, crown, and nape nearest to Cedar Green with a metallic sheen, changing to more golden on the back and uropygium; lores dark Sanford's Brown; a whitish post-ocular lunule; ear-coverts dusky. Throat Vinaceous-Cinnamon merging into dark Mikado Brown on breast, abdomen, and under tail-coverts. Wings Dark Livid Purple; shafts of outer three primaries enlarged and curved on the basal half; lesser wing-coverts green, uniform with the back; edge of wing and axillaries chestnut; greater under wing-coverts uniform with the remiges, the lesser ones bronzy. Two median pairs of rectrices and the basal halves of the others Old Gold, with a bronzy metallic sheen, and the terminal half of the outer three pairs light Hazel. Maxilla (in life) "black"; mandible "flesh, black tip"; feet "flesh and black"; iris "dark."

Wing, 63 mm.; tail, 42; exposed culmen, 22; culmen from base, 26.5; tarsus, 6.5.

REMARKS: Sexes alike in coloration, but the females are distinguishable by not having the shafts of outer primaries enlarged and curved. Range of measurements: eight adult males: wing, 59.5–63 (61.3) mm.; tail, 41–43 (41.7); exposed culmen, 20–22 (20.5); six adult females: wing, 57.5–62 (58.5); tail, 38–42 (40.5); exposed culmen, 19–22.5 (21). Measurements of six adult males of *C. d. duidae*: wing, 66–70 (68); tail, 47–49 (48); exposed culmen, 22–24 (23). Averages of the above males:

	WING	TAIL	EXPOSED CULMEN
<i>C. d. guaiquinimae</i>	61.3	31.7	20.5
<i>C. d. duidae</i>	68.0	48.0	23.0

It may be that *duidae* and *guaiquinimae* are not specifically distinct from *C. hyperythrus* of the Subtropical Zone of Mts. Roraima and Auyan-tepui. Peters (1945, "Check-list of birds of the world," vol. 5, p. 20) has already placed *duidae* in the species *hyperythrus*. *Hyperythrus* is distinguished by the deeper rufescent color of the under parts and by having the light-colored rectrices uniform brown without the bronzy basal half. However, three specimens of the Roraima series of 11 have the basal part of the inner web of the third rectrices bronzy. Seven of the nine specimens from Mt. Auyan-tepui have small bronze basal patches on the inner webs of the third rectrices, only. (The third rectrices are missing from one of the remaining two birds.) So it appears that the Auyan-tepui population is, to a certain extent, intermediate between *hyperythrus* and *duidae* and that all but five of the 20 specimens of *hyperythrus* can be allocated, respectively, to Roraima or Auyan-tepui.

Chapman (1931, Bull. Amer. Mus. Nat. Hist., vol. 63, p. 71) called attention to the similarity between the two groups, remarking, "That *duidae* and *hyperythrus* are mutually representative seems highly probable." Another close relative, *C. rufus*, inhabits the subtropics of Guatemala; it is considerably larger and has subapical dark patches on the rectrices. It is notable

that no form of *hyperythrus* or *duidae* was encountered on Mt. Ptari-tepui.

SPECIMENS EXAMINED

C. rufus.—GUATEMALA: 18.
C. hyperythrus.—VENEZUELA: Mt. Roraima, 5 ♂, 6 ♀; Mt. Auyan-tepui, 3 ♂, 6 ♀.
C. d. duidae.—VENEZUELA: Mt. Duida, 125 (including type).
C. d. guaiquinimae.—VENEZUELA (Phelps Collection): Mt. Guaiquinima, 11 ♂ (including type), 24 ♀.

Picumnus buffoni clarus, new subspecies

TYPE: From La Paragua, lower Paragua River, State of Bolívar, Venezuela; altitude 280 meters. No. 16118, Phelps Collection, Caracas. Adult male collected January 12, 1942, by William H. Phelps. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Differs from *P. b. buffoni* in being whiter below, with the light ground almost pure white with only a slight yellowish tinge; back and wing-coverts paler, more grayish olive, less yellowish olive, and without the prominent white spots; the back has a scalloped appearance absent in *buffoni*. Differs from *P. b. undulatus* in having the upper parts paler and the under parts whiter because of the narrower black bars and the wider pale interspaces.

RANGE: The lower Paragua River, below the Uraima Falls, and the Cuyuni River watershed from El Dorado in the south to El Palmar in the north, in the eastern part of the State of Bolívar.

DESCRIPTION OF TYPE: Crown and nape black, the feathers of forehead with elongate Flame Scarlet tips, those of crown and nape with small rounded white spots; feathers of back and uropygium olive yellow with a dusky median spot and a subterminal semilunar band giving a scalloped appearance; lores and nasal feathering pale buff with fine blackish tips; sides of head white with traces of dusky bars. Below white with a slight yellowish wash across the breast and barred with black, with the barring finer on chin and throat. Remiges Natal Brown, finely edged with yellowish buff, broader on secondaries and tertials where there are some dark marginal

spots; greater, median, and lesser upper wing-coverts with dark subterminal spots and with light terminal margins; under wing-coverts and basal edgings of remiges on inner webs pale cream. Tail largely black; inner webs of median rectrices creamy white; two outer pairs of rectrices with white bars crossing diagonally and subterminally. Maxilla (in life) "horn-color"; feet "olive"; iris "dark." Wing, 51.5 mm.; tail, 26; culmen from base, 13.5; tarsus, 12.

REMARKS: The female is similar except that the scarlet of the forehead is replaced by white spots uniform with those of the crown. Young similar but with the head barred with gray and dusky and the markings on the back less prominent. Size similar to *buffoni* and *undulatus*. Range of measurements: five adult males: wing, 51.5–54.5 (53.4) mm.; tail, 25–28 (27); culmen from base, 13–13.5 (13.3); five adult females: wing, 50–53 (51.7); tail, 25–27 (26.4); culmen from base, 12–13 (12.7).

The population to the east of the type locality, the Cuyuni River watershed, has the under parts yellower, thus approaching *buffoni* in this character; above it is darker, thus approaching *undulatus* in this character only.

SPECIMENS EXAMINED

P. b. buffoni.—FRENCH GUIANA: 7 ♂, 1 ♂ juv., 8 ♀, 1 ♀ juv., 1 (?) juv.

P. b. clarus.—VENEZUELA (Phelps Collection): La Paragua, 6 ♂ (including type), 5 ♀; Cerro Tigre, near La Paragua, 2 ♀, 2 (?) juv.; El Dorado, 2 ♂, 3 ♀; Altiplanicie de Nuiña, 2 ♂; El Palmar, 1 ♂, 1 ♀, 1 (?) ♀.

P. b. undulatus.—VENEZUELA: Mt. Auyan-tepui, 1 ♂, 4 ♀, 1 (?) juv.; La Unión, 1 ♂, 2 ♀; Maripa, 1 ♂; Nichare River, 1 ♂, 1 ♀, 1 ♀ juv.; Suapure, 3 ♂; La Prisión, 1 ♀; Nericagua, 1 ♂, 1 ♀; Boca de Sina, 1 ♀, 2 ♀ juv.; (Phelps Collection): these upper Paragua River localities: Salto Uraima, 1 ♀; Caño Tonoro, 1 ♂; Salto Guaikinima, 1 ♂, 1 ♀; Raudal Capuri, 3 ♂, 1 ♀, 1 ♀ juv.; Salto María Espuma, 6 ♂, 4 ♀, 1 (?) juv.

Dysithamnus mentalis ptaritepui, new subspecies

TYPE: From Mt. Ptari-tepui, Gran Sabana, State of Bolívar, Venezuela; altitude 1800 meters. No. 27106, Phelps

Collection, Caracas. Adult female collected August 2, 1944, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: The male is very similar to that of *D. m. spodionotus* of Mts. Roraima and Auyan-tepui but with the top of the head less deeply blackish and the back clearer gray in less contrast to the crown. The female differs from that of *spodionotus* by having the back, uropygium, sides, flanks, and a wash across the breast much more olivaceous, less ochraceous brown.

RANGE: Known only from the southwestern slope of Mt. Ptari-tepui, and the northern slope of adjacent Mt. Sororopán-tepui, at altitudes of 1300 to 1800 meters.

DESCRIPTION OF TYPE: Forehead and anterior crown near Auburn with paler shaft streaks; back of head darker, near Argus Brown, with shaft streaks less prominent; back and uropygium near Saccardo's Olive; lores dull buffy; an indistinct superciliary stripe light buffy brown; a narrow white orbital ring; ear-coverts dusky brown with pale shafts. Center of chin and throat whitish mixed with buffy, darker laterally; sides, flanks, and shanks, under tail-coverts, and a slightly fainter wash across the breast light grayish olive; abdomen white. Wings fuscous; tertials and outer webs of remiges brownish, paler towards the edge of wing; upper wing-coverts brownish; under wing-coverts grayish white; inner webs of remiges, except the outermost, narrowly edged with buff except towards the tips. Tail browner, less olivaceous than the back. Maxilla (in life) "black"; mandible "bluish gray"; feet "gray"; iris "brown." Wing, 60 mm.; tail, 41; exposed culmen, 13; culmen from base, 17; tarsus, 19.

REMARKS: Description of adult male (No. 27107, Phelps Collection): Crown, forehead, sides of head, and nape Dusky Neutral Gray; back Slate Color × Blackish Slate, paler on upper tail-coverts. Chin and throat whitish with grayish tips, darker on the sides; breast and sides Deep Gull Gray × Dark Gull Gray, with a slight olivaceous tinge on the flanks; abdomen and lower tail-coverts white with slightly grayer tips. Wings blackish, the remiges

edged with olivaceous, whitish on outer primaries; upper wing-coverts uniform with the back, the lesser coverts and scapulars with indications of white tips; bend of wing and under wing-coverts mixed white and gray; inner webs of remiges, except the outer, narrowly edged with pale lemon yellow except towards the tips. Tail fuscous with feathers edged with slate, the central ones almost uniform with the back and all very faintly and narrowly barred with dusky.

Young males have a dusky crown, olive green back, gray throat, and yellowish olive abdomen. Young females differ principally from the adults of that sex by having a lighter back and a strong yellowish suffusion below, especially on the abdomen.

Size is similar to *D. m. spodionotus*. Range of measurements: five adult males: wing, 61–66 (63.6) mm.; tail, 42–45 (43.5); culmen from base, 18–19 (18.6); five adult females: wing, 60–64 (62.2); tail, 40–44 (42.3); culmen from base, 17–19 (18.1).

The Mt. Auyan-tepui males are like *spodionotus* of Roraima. The females are intermediate in the coloration of both upper and under parts but are also nearer to *spodionotus*. The males from Mt. Duida are similar to those of *D. m. spodionotus*. The females also are closer to that form than to the new *D. m. ptaritepui*.

SPECIMENS EXAMINED

D. m. mentalis.—BRAZIL: Ubatuba, 1 ♂; Itararé, 1 ♂, 1 ♀; Piquete, 2 ♂, 1 [♂], 1 [♀]; S. Sebastião, 3 ♂, 1 ♀; Ponte Maromba, 1 ♂, 1 ♀; Therezopolis, 2 ♂; Victoria, 1 ♂. ARGENTINA: Puerto Segundo, Misiones, 2 ♂.

D. m. affinis.—BRAZIL: 43.

D. m. emiliae.—BRAZIL: Baião, 1 ♂, 1 ♀; Prata, Pará, 1 ♀.

D. m. spodionotus.—VENEZUELA: Arabupú, 8 ♂, 14 ♀, 4 ♂ [juv.]; Mt. Auyan-tepui, 4 ♂, 1 ♂ [juv.], 4 ♀; Mt. Duida, 4 ♂, 4 ♀; (Phelps Collection): Arabupú, 7 ♀; Mt. Auyan-tepui, 3 ♀.

D. m. ptaritepui.—VENEZUELA (Phelps Collection): Mt. Ptari-tepui (1300–1800 meters), 8 ♂, 2 ♂ [juv.], 2 [♂ juv.], 7 ♀ (including type), 1 [♀], 2 [♀ juv.]; Mt. Sororopán-tepui (1500 meters), 1 ♂, 1 [♂ juv.], 1 ♀.

D. m. oberi.—TOBAGO ISLAND: 1 ♂, 3 ♀.

D. m. andrei.—TRINIDAD: 13 ♂, 5 ♀.

D. m. cumbrenus.—VENEZUELA: San Esteban,

1 ♂; Las Quiguas, 1 ♀; El Limón, D. F., 1 ♀; Quebrada Seca, 1 [♂]; El Guácharo, 1 ♂; Caripe, 1 [♂]; Los Palmales, 1 ♀; Los Dos Ríos, 1 ♀; Rincón de San Antonio, 1 ♀; Cristóbal Colón, 2 ♂, 2 ♀.

D. m. semicinctus.—COLOMBIA: 20.

D. m. suffusus.—PANAMÁ: Tacarcuna, 15 ♂, 2 [♂ juv.], 16 ♀.

D. m. septentrionalis.—COSTA RICA: Bonilla, 2 ♂, 1 ♀; Aquinares, 3 ♂, 3 ♀; Carillo, 2 ♂, 1 ♀; Navarro, 3 ♂, 2 ♀; Navarito, 1 ♂; Guayabo, 2 ♂, 2 ♀. PANAMÁ: Chiriquí, 2 [♂], 1 ♀.

D. m. extremus.—COLOMBIA: Cauca, 1 ♂; Palmira, 4 ♂, 3 ♀; San Antonio, 3 ♂, 3 ♀; Las Lomitas, 2 ♂, 1 ♂, 2 ♀; Río Frío, Cauca, 3 ♂, 1 ♀; Primavera, 5 ♂, 1 ♀; Salento, 1 ♂, 1 ♀.

D. m. aequatorialis.—ECUADOR: 66. PERÚ: 2.

D. m. napensis.—ECUADOR: 10.

D. m. tambillanus.—PERÚ: 17.

D. m. olivaceus.—PERÚ: 12.

D. m. tavarae.—PERÚ: 21. BOLIVIA: 8.

Schistocichla leucostigma obscura, new subspecies

TYPE: From Mt. Sororopán-tepui (adjoining Mt. Ptari-tepui), Gran Sabana, State of Bolívar, Venezuela; altitude 1400 meters. No. 27201, Phelps Collection, Caracas. Adult male collected August 25, 1944, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: The male is distinctly blacker than any of the other known races of *S. leucostigma*. The female approaches *S. l. saturata* of Mt. Roraima, but the back is darker, darker brown and less rufous, and the crown is blacker with less olivaceous tinge; below the flanks are darker, browner, less brightly rufous.

RANGE: Lower Subtropical Zone on Mts. Ptari-tepui, nearby Sororopán-tepui, and Auyan-tepui.

DESCRIPTION OF TYPE: Head, back, and uropygium Dusky Neutral Gray. Below, except tail, Blackish Slate. Remiges and primary-coverts blackish, deeper along outer margins of secondaries and tertiaries; wing-coverts black with white terminal spots; under wing-coverts uniform with under parts. Tail similar to back but with a slightly brownish tinge, paler on the under aspect. Bill (in life) "black"; feet "black"; iris "brown." Wing, 68 mm.;

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. VII" (1932, Amer. Mus. Novitates, no. 558, p. 9).

tail, 60; exposed culmen, 18; culmen from base, 21; tarsus, 27.

REMARKS: Description of adult female (No. 27190 Phelps Collection): Top of head Dark Mouse Gray with dusky tips to the feathers, more grayish on forehead; back and uropygium dark Prout's Brown; sides of head grayish. Point of chin whitish buff; breast Hazel $\times$ Sanford's Brown, slightly paler on throat and abdomen; thighs, shanks, and under tail-coverts much darker and browner. Wings Clove Brown, paler on under surface; remiges finely edged externally with Prout's Brown $\times$ Mummy Brown; greater and median wing-coverts spotted terminally with buff; under wing-coverts grayish. Tail Fuscous-Black, paler on under surface. Maxilla (in life) "black"; mandible "gray, tip black"; feet "gray"; iris "brown." Wing, 65 mm.; tail, 55; exposed culmen, 17.5; culmen from base, 21; tarsus, 24.5.

Size similar to *S. l. saturata*. Range of measurements: five adult males: wing, 65-68 (66.8) mm.; tail, 56-60.5 (58.3); culmen from base, 20-22 (21.2); five adult females: wing, 64-66 (65); tail, 52.5-57 (55.2); culmen from base, 20-21 (20.8).

The two specimens from Mt. Auyan-tepui are similar to the topotypical series. Although we have seen only one male of *saturata*, a relatively recent specimen, collected in 1938, it demonstrates such positive distinction from the same sex of the birds described herewith that we are confident of the characters given. In addition, the various females of *saturata*, of which we have an adequate series, show the same degree of distinction in the same direction as the single male, i.e., a generally lighter tone than in *obscura*, which was to be expected.

SPECIMENS EXAMINED

S. l. leucostigma.—BRITISH GUIANA¹: 5.

S. l. rufifacies.—BRAZIL¹: 3.

S. l. humaythae.—BRAZIL¹: 5.

S. l. infusata.—BRAZIL: Tatú, Río Negro, 2 ♂, 1 ♀; Yavanari, Río Negro, 1 ♂. VENEZUELA: Río Guainía, junction with Casiquiare, 1 ♂, 1 ♀; mouth of Río Ocamo, 1 ♀.

S. l. brunneiceps.—PERÚ¹: 1.

S. l. intensa.—PERÚ¹: 5.

S. l. subplumbea.—COLOMBIA¹: 5. ECUADOR¹: 13. PERÚ¹: 13.

S. l. saturata.—VENEZUELA: Arabupú, 1 ♀; (Phelps Collection): Mt. Roraima, 1 ♀; Arabupú, 1 ♂, 3 ♀.

S. l. obscura.—VENEZUELA: Mt. Auyan-tepui (1100 meters), 1 ♂, 1 ♀; (Phelps Collection): Mt. Ptari-tepui (1300-1360 meters), 6 ♂, 4 [♂], 8 ♀, 2 [♀]; Mt. Sororopán-tepui (1400 meters), 1 ♂ (type).

S. caurensis.—VENEZUELA: Río Chanaro (mouth), Río Caura, 1 [♂]; El Yagual, 1 ♂, 2 ♀; Caño Seco, Duida, 2 ♂, 1 ♀; Valle de los Monos, 2 ♀; Pie del Cerro, Duida, 1 ♀.

Myrmothera simplex guaiquinimae, new subspecies

TYPE: From Mt. Guaiquinima, Paragua River, State of Bolívar, Venezuela; altitude 1540 meters. No. 28825, Phelps Collection, Caracas. Adult male collected January 26, 1945, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Nearest to *M. s. duidae*, from Mt. Duida, from which it differs by having greener, less ochraceous brown sides, flanks, and wash across the breast. From *M. s. simplex*, from Mts. Roraima, Auyan-tepui, and Ptari-tepui, it differs in having brighter upper parts (yellow, less brownish), and stronger olivaceous wash across the breast.

RANGE: Known only from the north-western slopes of Mt. Guaiquinima at altitudes from 1200 to 1540 meters.

DESCRIPTION OF TYPE: Above Amber Brown $\times$ Argus Brown, paler on the upper tail-coverts; lores broadly whitish; a prominent postocular white lunule; an indistinct dusky malar stripe; elongated ear-coverts dusky olive. Chin and throat white, with fine, blackish, hair-like tips; malar region grayish; breast gray washed with Orange-Citrine $\times$ Medal Bronze, stronger laterally; sides, flanks, and under tail-coverts Dresden Brown $\times$ Orange-Citrine; abdomen gray mixed with white centrally. Primaries and secondaries blackish; outer margins of all but the outermost primary Brussels Brown $\times$ Antique Brown; tertials, upper wing-coverts, and outer webs of secondaries rufous brown uniform with the back; under wing-coverts dusky olive; inner webs of inner primaries and

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. 1" (1931, Amer. Mus. Novitates, no. 500, p. 20).

secondaries basally lighter brown. Tail similar to the back but slightly duller. Bill (in life) "black with grayish-white base"; feet "grayish-slate"; iris "dark." Wing, 86 mm.; tail, 45; exposed culmen, 18; culmen from base, 24.5; tarsus, 43.

REMARKS: Sexes alike. Size similar to the other races. Range of measurements: six adult males: wing, 83–86 (84.6) mm.; tail, 41–46 (44.3); culmen from base, 23–25 (23.9); six adult females: wing, 80–86 (83.5); tail, 40–46 (43.5); culmen from base, 22–22.5 (22.2).

SPECIMENS EXAMINED

M. s. simpler.—VENEZUELA: Mt. Roraima, 1 ♂; Philipp Camp (1800 meters), 1 ♂; Mt. Auyan-tepui (1850 meters), 1 ♂, 2 (?); (Phelps Collection): Mt. Auyan-tepui (1850 meters), 1 ♂; Mt. Ptari-tepui (1700–2000 meters), 8 ♂, 4 ♀, 1 (?), 1 (?) [juv.].

M. s. duidae.—VENEZUELA: Mt. Duida (1530–1860 meters), 6 ♂ (including type), 2 ♀.

M. s. guaiquinimae.—VENEZUELA (Phelps Collection): Mt. Guaiquinima (1200–1540 meters), 6 ♂ (including type), 6 ♀.

Myiarchus swainsoni fumosus, new subspecies

TYPE: From Mt. Ptari-tepui, Campamento Misia Kathy, Gran Sabana, State of Bolívar, Venezuela; altitude 1300 meters. No. 27362, Phelps Collection, Caracas. Adult male collected August 16, 1944, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: This new form has the upper parts darker than any of the other known races of *M. swainsoni*. It is nearest to *M. s. phaeonotus* of the Roraima and Duida regions, but the crown is blacker, less brownish, the back is duskier, less olivaceous, and the wings and tail are inclined to be darker.

RANGE: The Subtropical Zone of Mts. Ptari-tepui and Guaiquinima, and the lower Subtropical Zone of Mts. Auyan-tepui, Tonoro, and Sarisariñama, all in the southern part of the State of Bolívar.

DESCRIPTION OF TYPE: Top and sides of head Chaetura Black; back and rump Chaetura Drab, upper tail-coverts less dusky. Chin and throat grayish white merging into the Pale Gull Gray of the breast; abdomen and under tail-coverts

Pale Chalcedony Yellow; sides and flanks grayish olive. Wings Clove Brown × Bone Brown; secondaries edged externally with brownish olive; tertials with edges more whitish; median and greater wing-coverts edged externally with grayish forming two indistinct wing bands; pale inner edgings of remiges, except terminally, decreasing on outer feathers; under wing-coverts and axillaries uniform with the abdomen. Tail Fuscous-Black; outermost rectrices very narrowly edged externally with whitish; shafts of rectrices brownish black on upper aspect and lighter brown on lower. Bill (in life) "black"; feet "black"; iris "brown." Wing, 89.5 mm.; tail, 78; exposed culmen, 16; culmen from base, 20.5; tarsus, 19.

REMARKS: Sexes alike. Size similar to *M. s. phaeonotus*. Range of measurements: five adult males: wing, 89.5–92.5 (91) mm.; tail, 77–82 (79.4); culmen from base, 20.5–21.5 (20.7); five adult females: wing, 85–89.5 (87.1); tail, 73–78.5 (76.3); culmen from base, 20–23 (21.2).

The new race is definitely subtropical as it has been found only on these mountains and at the following elevations: Mt. Ptari-tepui, 1200 to 1800 meters; Mt. Auyan-tepui, 1100 meters; Mt. Tonoro, 700 meters; Mt. Guaiquinima, 1500 meters; and Mt. Sarisariñama, 1100 meters.

The topotypical specimens from Mt. Ptari-tepui are the darkest of all, but those listed from the other mountains, though intermediates, are closer to the new race than to any other.

Of the other two races found in southern Venezuela, *swainsoni*, supposedly a migrant, has been taken only in Tropical Zone localities, while *phaeonotus* inhabits both the lower subtropics and tropics. The latter has been taken on Mt. Duida as high as 1440 meters, but it also occurs in the tropics at the base of that mountain as well as at San Fernando de Atabapo and on the upper Rio Negro in Brazil.

SPECIMENS EXAMINED

M. s. pelzelni.—BRAZIL¹: 17. PERÚ¹: 1. BOLIVIA¹: 1.

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXIX" (1938, Amer. Mus. Novitates, no. 994, pp. 8–9).

M. s. ferocior.—ARGENTINA¹: 7. BOLIVIA¹: 3.

M. s. amazonus.—BRAZIL¹: 14. BRITISH GUIANA¹: 2.

M. s. swainsoni.—BRAZIL¹: 42. PARAGUAY¹: 4. VENEZUELA (all supposedly migrants): Ciudad Bolívar, 1 ♀; Agua Salada de Ciudad Bolívar, 1 ♀; Perico, 1 ♂; Buena Vista, 1 (?); Solano, 1 ♀; Río Ocamo (mouth), 2 ♀.

M. s. phaeonotus.—BRITISH GUIANA¹: 1. BRAZIL¹: 7. VENEZUELA: Mt. Roraima, 3; Arapupú, 4; Mt. Duda, Valle de los Monos, 1 ♀; Caño León, 2 ♂, 1 ♀, Cumbie No. 1, 1 ♂, 1 ♀; Summit Camp, 1 (?); Chorrorea de Vegas, 2 ♂, 1 ♀; (Phelps Collection): Arapupú, 3 ♂, 4 ♀; San Fernando de Atabapo, 1 ♂, 1 ♀.

M. s. fumosus.—VENEZUELA: Mt. Auyan-tepui, 2 ♂, 2 ♀; (Phelps Collection): Mt. Pari-tepui, 8 ♂ (including type), 4 ♀, 2 (?); Mt. Auyan-tepui, 2 ♂, 1 ♀; Mt. Tonoio, 1 (?); Mt. Guaiquinima, 1 ♂; Mt. Sarisariñama, 1 ♂, 3 ♀.

***Myiarchus ferox brunescens*,
new subspecies**

TYPE: From Guasqualito, State of Apure, Venezuela; altitude 200 meters. No. 2667, Phelps Collection, Caracas. Adult male collected March 21, 1939, by Ventura Barnés. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Differs from all other races of *M. ferox* by having browner upper parts; brownish olive, instead of gray, breast; brownish gray, instead of whitish gray, throat; and cinnamon, instead of lemon yellow, under wing-coverts and under tail-coverts.

RANGE: The Apure River watershed from Camaguán in the east to its headwaters near the Colombian border; along the Orinoco River from Altagracia to Puerto Ayacucho and across the prairies to Villavicencio in Colombia.

DESCRIPTION OF TYPE: Forehead, sides of head, and crown Mummy Brown, the feathers of head with dusky shaft stripes; back a little lighter; posterior rump still lighter; upper tail-coverts warmer brown, margined with rufous. Breast Drab-Gray, merging into the paler gray throat and dull Colonial Buff × Olive-Buff abdomen; sides and flanks brownish olive; shanks cinnamon brown; under tail-coverts light

Cinnamon-Buff × Pinkish Cinnamon. Wings blackish brown; secondaries and tertials edged externally with buff; greater and median upper wing-coverts broadly tipped with dull grayish drab, forming two indistinct bars; under wing-coverts and axillaries Cinnamon-Buff, darker than the under tail-coverts; inner edges of the remiges, except terminally, paler. Tail dark Olive-Brown, more grayish on the under aspect, the rectrices very narrowly edged on the outer webs with ochraceous. Bill (in life) "black"; feet "black"; iris "brown." Wing, 85.5 mm.; tail, 77; exposed culmen, 18.5; culmen from base, 22; tarsus, 23.

REMARKS: Sexes alike. Size similar to *M. f. australis*. Range of measurements: four adult males: wing, 85–88 (86.7) mm.; tail, 77–83 (80); culmen from base, 22–23 (22.7); five adult females: wing, 83–86 (83.8); tail, 77–81 (79); culmen from base, 22–22.5 (22.3).

Specimens from Cabruta (across the river from Caicara), Caicara, Altagracia, Perico (Puerto Ayacucho), and Villavicencio (in Colombia) are intermediates but a little closer to *M. f. brunescens*. *Australis* has been collected to the east of the new race in the State of Guarico and in the Caura Valley.

SPECIMENS EXAMINED

M. f. actiosus.—COSTA RICA²: 13.
M. f. panamensis.—COLOMBIA²: 26. PANAMA²: 42. COSTA RICA²: 1.
M. f. venezuelensis.—VENEZUELA: Puerto de la Cruz, D. F., 1 ♂; Las Trincheras, 1 ♂.
M. f. brunescens.—VENEZUELA: Altagracia, 2 ♂, 1 ♀; Perico, 1 ♂; Caicara, 1 ♂; (Phelps Collection): Guasqualito, 2 ♂ (including type), 1 (?); Santo Domingo, Táchira, 2 ♂, 3 ♀, 2 (?); Camaguán, 1 ♀; Guanare, 1 ♀; Cabruta, 1 ♂. COLOMBIA: Villavicencio, 1 ♂, 3 ♀.
M. f. ferox.—VENEZUELA: Boca de Sina, 2 ♀; Esmeralda, 2 ♂, 2 ♀; La Laja, 3 ♂, 3 ♀; Río Ocamo (mouth), 3 ♂, 1 ♀; El Merey, 1 ♂, 2 ♀, 1 (?); Mt. Auyan-tepui, 1 ♂; (Phelps Collection): Salto Uraima, 1 ♂; Raudal Capuri, 4 ♂, 1 (?); Salto Maiza, 2 (?); Erebenequén, 1 ♂, 1 ♀. FRENCH GUIANA²: 12. DUTCH GUIANA²: 5. BRITISH GUIANA²: 1. BRAZIL²: 172. PERU²: 14. ECUADOR²: 8. COLOMBIA²: 3.
M. f. australis.—VENEZUELA: Maripa, 1 ♂, 1 ♀; Ciudad Bolívar, 1 ♂; Sacupana, 1 (?); Río Chanaro (mouth), 2 (?); La Unión, 1 ♂;

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXIX" (1938, Amer. Mus. Novitates, no. 994, pp. 8–9).

² For list of localities, see Zimmer (*ibid.*, pp. 14–15).

La Prisión, 1 (?); Río Mato, 1 ♂; "Río Orinoco", 1 ♂; (Phelps Collection): El Baúl, 1 ♀; Palenque, 2 ♀. BRAZIL: 43. PARAGUAY: 3. BOLIVIA: 6.

Myiarchus tuberculifer pallidus,
new subspecies

TYPE: From Las Trincheras, State of Carabobo, Venezuela. No. 50539, American Museum of Natural History. Adult male collected October 7, 1918, by George K. Cherrie; original no. 20629.

DIAGNOSIS: Nearest to *M. t. tuberculifer* of southern Venezuela to Bolivia, but back paler, more yellowish olive, less sooty olive.

RANGE: The Santa Marta region, Colombia, and northern Venezuela, southward across the Andes of Mérida to the northern edge of the Apure River valley.

DESCRIPTION OF TYPE: Top of head Chaetura Drab; back Citrine-Drab × Deep Olive with an ochraceous tint to the posterior rump; upper tail-coverts brownish with ochraceous edgings; lores and cheeks grayish. Chin and throat grayish with subobsolete whitish streaks; breast gray with an olivaceous wash posteriorly; abdomen Martius Yellow × Picric Yellow, paler on the under tail-coverts. Wings blackish brown; secondaries narrowly edged with olive buff; tertials with broader edges of paler, more grayish buff; median and lesser upper coverts edged and tipped with olive, more buffy than the back; bend of wing and under wing-coverts pale yellow; pale yellowish buffy basal edgings on inner webs of remiges. Tail Clove Brown, the rectrices, except the outermost, narrowly margined externally with olive brown; shafts of rectrices dark brown above, whitish brown on under aspect. Bill and feet (in dried skin) black. Wing, 78 mm.; tail, 71.5; exposed culmen, 17; culmen from base, 22; tarsus, 20.

REMARKS: Sexes alike. Size similar to *M. t. tuberculifer*. Range of measurements: five adult males: wing, 77–82 (78.8) mm.; tail, 69.5–72 (70.8); culmen from base, 19–22 (21); five adult females: wing, 74–79.5 (76.3); tail, 66–72 (68.7); culmen from base, 20–22 (20.8).

The senior author² has called attention to the fact that the birds from the northern coast of Venezuela and the Santa Marta region of Colombia were "distinctly paler and more greenish on the back..." than the more southern populations of *M. t. tuberculifer*. However, he said "a good series of fresh specimens from Santa Marta, the Orinoco, and the north coast of Venezuela will be needed to establish such distinction." Since then the Phelps Collection has supplied such series, from both the north coast and the lower Orinoco region, which have served to establish the suspected characters of the new race.

In the same paper the senior author called attention to the possibility that the name *coalei* Ridgway, labeled "Orinoco" and presumably a trade skin, might be available for the northern race if established. Dr. Friedmann, of the United States National Museum, kindly sent this type to us for examination, and it was found to be similar not to the paler north-coast population but to the darker Orinoco Valley one, so it must remain a synonym of *M. t. tuberculifer*.

SPECIMENS EXAMINED

- M. t. tresmariae*.—MÉXICO³: 6.
M. t. olivascens.—MÉXICO³: 15.
M. t. querulus.—MÉXICO³: 3.
M. t. platyrhynchus.—MÉXICO³: 3.
M. t. lawrencei.—GUATEMALA³: 27. MÉXICO³: 27.
M. t. connectens.—NICARAGUA³: 6. HONDURAS³: 96.
M. t. nigricapillus.—COSTA RICA³: 33. NICARAGUA³: 1.
M. t. bangsi.—PANAMÁ³: 24. COSTA RICA³: 14.
M. t. brunneiceps.—PANAMÁ³: 5. COLOMBIA³: 16.
M. t. nigriceps.—ECUADOR³: 28.
M. t. atriceps.—ARGENTINA³: 2. BOLIVIA³: 1.
M. t. clarus.—BRAZIL³: 8. DUTCH GUIANA³: 2.
M. t. tricolor.—BRAZIL³: 5.
M. t. tuberculifer.—VENEZUELA: Caicara, 1 ♂, 1 ♀; Nericagua, 2 ♀; Quiribana de Caicara, 1 ♂, 1 ♀; Puerto Ayacucho, 1 ♀; Río Ocamo (mouth), 1 ♂, 1 ♀; El Merey, 2 ♀; (Phelps Collection): La Paragua, 1 ♂; El Cambur, 1 ♂, 1 ♀; Caño Cataniapo, 1 ♀; San Fernando de Atabapo, 1 (?); Sabana

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXIX" (1938, Amer. Mus. Novitates, no. 994, pp. 14–15).

² "Studies of Peruvian birds. No. XXIX" (1938, Amer. Mus. Novitates, no. 994, pp. 19–20).

³ For list of localities, see Zimmer (*ibid.*, pp. 24–25).

Kirichú, 1 ♀. TRINIDAD: 2 ♂, 3 ♀. BRITISH GUIANA: Kamarang River, 1 ♂; (Phelps Collection): Paruima Mission, 1 ♂. BRAZIL¹: 7. BOLIVIA¹: 4. PERÚ¹: 8. ECUADOR¹: 3. COLOMBIA¹: 5.

M. t. pallidus.—VENEZUELA: Mérida, 2 ♀, 2 (?); Escorial, 1 ♀; Valle, 1 ♂; Culata, 1 ♂, 1 ♀; Loma Redonda, 1 ♂; El Guácharo, 1 ♂; Quebrada Seca, Sucre, 2 ♂; La Tigra, 2 ♂, 1 ♀; Los Dos Ríos, 1 ♂; Santa Ana Valley, 1 ♂; Campo Alegre Valley, 1 ♂, 1 ♀; Caripe, 2 (?); Latal, 1 ♂, 1 ♀; Río Neverí, 1 ♀; (Phelps Collection); La Sierra, 2 ♂, 2 ♀; La Sabana, 1 ♂, 1 ♀; Bramón, 1 ♂; Tabay, 1 ♀; Seboruco, 1 ♂, 2 (?); El Vigía, 1 ♀; Cerro El Cerrón, 1 ♂; San Luis, 2 ♂, 2 ♀; Chirgua, 1 ♂; Los Caracas, 1 ♀; Los Altos, 2 ♂; Quebrada Bonita, 1 ♂; Caripe, 1 ♀; Yaguaraparo, 1 (?); Ciudad Bolivia, 3 ♂, 1 ♀; La Veguita, 1 ♂. COLOMBIA: Santa Marta, Cacagualito, 1 ♂, 3 ♀; Onca, 2 [♂?], 1 [♀?]; Las Nubes, 1 ♀; Minca, 2 ♂, 4 ♀, 3 ♀?; Valparaiso, 3 [♀?].

Contopus fumigatus roraimae, new subspecies

TYPE: From Mt. Roraima, State of Bolívar, Venezuela; altitude 1500 meters. No. 497613, American Museum of Natural History. Adult female collected by Henry Whitely, August 9, 1883.

DIAGNOSIS: Nearest to *C. f. zarumae* of Ecuador and Perú but without whitish on chin or indication of light outer margins to outer webs of outer rectrices on the under aspect; crown and back blacker, less brownish. From *C. f. duidae* of Mts. Duida, Ptari-tepui, Sororopán-tepui, and Guaiquinima it is at once distinguished by paler and browner under parts and more brownish crown and back.

RANGE: Subtropical Zone of Mt. Roraima and presumably of Mt. Tweek-quay in British Guiana.

DESCRIPTION OF TYPE: Top of head Fuscous-Black; back and rump Deep Mouse Gray; upper tail-coverts browner with gray margins; sides of head dusky gray. Below Mouse Gray × Deep Mouse Gray, paler on chin and abdomen, and more brownish on under tail-coverts. Wings near Clove Brown, the edges of inner webs of remiges paler and the tertials narrowly edged on outer vane with grayish; under wing-coverts uniform with the breast.

Tail: Clove Brown, paler on under aspect, all but the outermost rectrices finely edged with grayish. Maxilla (in dried skin) black; mandible brownish flesh; feet black. Wing, 84 mm.; tail, 70; exposed culmen, 14; culmen from base, 18.5; tarsus, 13.5.

REMARKS: Sexes presumably alike, as they are in the other races of the species. Size similar to *C. f. duidae*. Measurement of a specimen of undetermined sex in the Phelps Collection: wing, 85 mm.; tail, 69; culmen from base, 18.

The senior author² had noted that this type specimen was different from any of the known races of the species, and he listed it as an unknown subspecies. He did not know how much the specimen might have foxed during the 62 years since it was collected. The fresh specimen in the Phelps Collection, collected in 1938, shows that the Whitely skin is very little browner, less dusky, either above or below.

Chubb³ lists and describes a male from Mt. Tweek-quay, British Guiana, which is in the British Museum. He compared it with a female from Mt. Roraima, saying that it was darker and larger. Geographically this specimen should also belong to this new race. Hellmayr⁴ says: "In the mountains of British Guiana (Roraima, Tweek-quay) an additional race exists which I am unable to determine. Two specimens in worn plumage so closely resemble *M. f. zarumae* that I cannot find a single character of distinction either in size or color." The "Catalogue of birds in the British Museum" (1888, vol. 14, p. 237) lists three Whitely specimens (as *C. ardesiacus*), two from Mt. Roraima and one from Mt. Tweek-quay. Presumably the skins examined by Hellmayr were among these.

SPECIMENS EXAMINED

C. f. brachyrhynchus.—ARGENTINA⁵: 4. BOLIVIA⁵: 1.

C. f. fumigatus.—BOLIVIA⁵: 5. PERÚ⁵: 2.

C. f. zarumae.—ECUADOR⁵: 21. PERÚ⁵: 7.

C. f. ardesiacus.—PERÚ⁵: 22. ECUADOR⁵: 5. COLOMBIA⁵: 24.

¹ "Studies of Peruvian birds. No. XXX" (1939, Amer. Mus. Novitates, no. 1042, p. 2).

² "Birds of British Guiana" (1921, vol. 2, p. 224).

³ "Catalogue of birds of the Americas, etc." (1927, Field Mus. Nat. Hist., zool. ser., vol. 13, pt. 5, p. 202).

⁴ For list of localities, see Zimmer, *loc. cit.*

⁵ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXIX" (1938, Amer. Mus. Novitates, no. 994, pp. 24-25).

C. f. cineraceus.—VENEZUELA: Loma Redonda, 1 ♂; Galipán, 1 ♀; Mérida, 4 (?) ; El Loro, 1 (?) ; Páramo del Mono, 1 ♀; Santo Domingo, Mérida, 1 ♂; Valle, 2 ♂.

C. f. duidae.—VENEZUELA: Mt. Duida, Summit Camp, 1 ♂ (type); Laterite Valley, 1 ♂, 2 ♀; (Phelps Collection): Mt. Ptari-tepui, 3 ♂, 1 ♂ juv., 1 ♀; Mt. Sororopán-tepui, 3 ♂, 2 ♀, 1 (?) ; Mt. Guaiquinima, 1 ♀.

C. f. roraimae.—VENEZUELA: Mt. Roraima (1500 meters), 1 ♀ (type); (Phelps Collection): Mt. Roraima, 1 (?) .

C. f. lugubris.—PANAMÁ¹: 6. COSTA RICA¹: 14.

C. f. minor.—NICARAGUA¹: 7.

C. f. pectinax.—GUATEMALA¹: 20. MÉXICO¹: 26.

C. f. pallidiventris.—MÉXICO¹: 2. UNITED STATES¹: 34.

***Platyrrhynchus mystaceus ptaritepui*,
new subspecies**

TYPE: From Mt. Ptari-tepui (south-western slope), Gran Sabana, State of Bolívar, Venezuela; altitude 1700 meters. No. 27388, Phelps Collection, Caracas. Adult male collected July 31, 1944, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Nearest to *P. m. duidae*, of Mts. Duida and Roraima, but above darker olive, less brownish. Below more yellowish ochraceous, less brownish, especially across breast and sides. Base of auriculars paler and duller.

RANGE: Known only from the Subtropical Zone on Mt. Ptari-tepui, and on nearby Mt. Sororopán-tepui, at altitudes from 1300 to 1800 meters.

DESCRIPTION OF TYPE: Forehead and crown dusky olive; a semi-concealed Lemon Chrome crown patch; back and uropygium dark Saccardo's Olive; eyelids and postocular stripe buff; a postocular dusky patch formed by the terminal half of the auriculars; basal half of auriculars buffy; a wide dusky subocular patch. Chin and throat white tinged with buffy yellow, strongest laterally; breast, sides, and flanks chamois, paler on abdomen and under tail-coverts. Wings blackish brown; outer edges of remiges, except outermost, Dresden Brown; tips of greater and median wing-coverts Buckthorn Brown, form-

ing two indistinct bands; bend of wing buffy; under wing-coverts and axillaries buffy white; inner webs of remiges, except outermost, narrowly edged, except terminally, with pale buffy. Tail fuscous; rectrices finely edged outwardly, except the outermost, with brownish olivaceous. Maxilla (in life) "black"; mandible "flesh"; feet "flesh"; iris "brown." Wing, 57 mm.; tail, 30.5; exposed culmen, 9; culmen from base, 14; tarsus, 17.

REMARKS: The female lacks the yellow crown patch and is slightly smaller than the male. The young bird has a rufous cast to the back. Size similar to *P. m. duidae*. Range of measurements: five adult males: wing, 55–58 (56.3) mm.; tail, 26–30.5 (27.8); culmen from base, 13–14 (13.7); four adult females: wing, 51–53 (51.7); tail, 25–27.5 (26.1); culmen from base, 13–14 (13.6).

SPECIMENS EXAMINED

P. m. mystaceus.—BRAZIL²: 20.

P. m. bifasciatus.—BRAZIL²: 14.

P. m. zamorae.—PERU²: 6. ECUADOR²: 11.

P. m. albogularis.—ECUADOR²: 17.

P. m. insularis.—TOBAGO²: 10. TRINIDAD²: 10. VENEZUELA: Near Mt. Bucarito, 1 ♂, 1 ♀; Tucacas, 1 ♂, 1 ♀, 1 (?) ; Las Trincheras, 1 ♂; San Esteban, 1 ♂, 1 ♀; San Félix, Sucre, 1 ♀; Cristóbal Colón, 3 ♂, 1 ♀; Agua Salada de Ciudad Bolívar, 1 ♀; Caicara, 1 ♀; Las Bariancas, 1 ♂; "Orinoco skin," 1 ♂.

P. m. imatacae.—VENEZUELA (Phelps Collection): Cerro Tomasote, 1 ♂ (type).

P. m. ptaritepui.—VENEZUELA (Phelps Collection): Mt. Ptari-tepui (1300–1800 meters), 4 ♂ (including type), 1 [♂], 1 [♂ juv.], 4 ♀, 2 (?) ; Mt. Sororopán-tepui (1500–1600 meters), 1 ♂, 1 [♂], 1 ♀.

P. m. duidae.—VENEZUELA: Laterite Valley, Mt. Duida, 1 ♂ (type); "Roraima," 1 ♀; Paulo, 1 ♂, Arabupá, 2 ♀; (Phelps Collection): Arabupá, 3 ♂, 2 ♂ [juv.], 1 ♀.

P. m. neglectus.—COLOMBIA²: 6. PANAMÁ²: 26. COSTA RICA²: 11.

P. m. dilutus.—COSTA RICA²: 6. NICARAGUA²: 8.

P. m. cancriminus.—NICARAGUA²: 8. GUATEMALA²: 9.

***Elaenia cristata alticola*, new subspecies**

TYPE: From Kabanayén, near Mt. Ptari-tepui, Gran Sabana, State of Bolívar, Venezuela; altitude 1200 meters. No.

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXX" (1939, Amer. Mus. Novitates, no. 1042, p. 2).

² For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXXI" (1939, Amer. Mus. Novitates, no. 1043, p. 8).

27985, Phelps Collection, Caracas. Adult male collected September 7, 1944, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Above much darker than *E. c. cristata*, with somewhat duller edgings to the primaries and duller wing bars. Below darker and grayer.

RANGE: Known only from the lower Subtropical Zone on the savanna at Kabanayén, near Mt. Ptari-tepui, and on Mt. Auyan-tepui; also from the Tropical Zone on the lower Paragua River.

DESCRIPTION OF TYPE: Upper surface Deep Grayish Olive, more grayish on the forehead, with somewhat prominent wide Bone Brown shaft areas, especially prominent on the crest; uropygium clearer; lores more whitish; subocular region grayish; ear-coverts brown. Chin and throat whitish merging into the yellowish gray under parts, more grayish on the breast and more yellowish (Naphthalene Yellow) on the abdomen. Wings blackish; primaries, except outermost, narrowly edged externally with grayish; secondaries more broadly edged with Marguerite Yellow; tertials broadly edged, externally, with whitish; greater and median wing-coverts broadly tipped with Pale Olive-Buff forming two prominent bars; bend of wing Marguerite Yellow; under wing-coverts and axillaries uniform with the under parts; edges of inner webs of remiges paler, except terminally. Tail blackish brown; rectrices, except outermost, finely edged externally with olivaceous and tipped with grayish; outer webs of outermost rectrices paler; shafts of rectrices blackish brown on upper aspect, whitish on lower. Bill (in life) "black"; feet "black"; iris "brown." Wing, 69 mm.; tail, 57; exposed culmen, 11; culmen from base, 15; tarsus, 20.5.

REMARKS: Sexes alike in coloration but female slightly smaller. Size similar to *E. c. cristata*. Range of measurements: five adult males: wing, 68–73 (70.7) mm.; tail, 57–63 (60.2); culmen from base, 14.5–16 (15.1); five adult females: wing, 67–69 (68.1); tail, 55–59 (56.8); culmen from base, 14–15 (14.6).

As far as we know, the species *E. cristata* has been known hitherto only from the

Tropical Zone with a range extending from south-central Brazil west to Perú and north to the Caribbean coast. Through this wide area it seems not to have differentiated until it extended its range vertically into the scrub on the high, cold savanna near the base of Mt. Ptari-tepui, at the northern edge of the Gran Sabana, where it is abundant.

The specimens from Mt. Auyan-tepui (1100 meters) and Cerro Perro (lower Paragua River, 300 meters) are intermediate between *E. c. cristata* and the new form, but closer to the latter.

SPECIMENS EXAMINED

E. c. cristata.—BRAZIL: 30. FRENCH GUIANA¹: 6. DUTCH GUIANA¹: 3. BRITISH GUIANA¹: 2. VENEZUELA: Roraima, 2 ♂; Valle de los Monos, Duida, 1 ♂, 4 ♀; Esmeralda, 11 ♂, 15 ♀; Altagracia, 3 ♂, 1 ♀, 1 (?); Caicara, 1 ♂; Quiribana de Caicara, 1 ♀; Maripa, 2 ♂, 1 ♀; Agua Salada de Ciudad Bolívar, 1 ♂; Ciudad Bolívar, 1 ♂, 1 ♀; (Phelps Collection): Altiplanicie de Nuria, 4 ♂; San Felipe (Hato), Tumeremo, 1 ♂ juv., 1 ♀; Sabana Caranacuni, 1 ♀; Sabana Kirichú, 1 ♂; Sanariapo, 1 ♀; Maripa, 1 ♂; Ciudad Bolívar, 1 ♀; Quebrada Candelarita, Ciudad Bolívar, 1 ♂, 2 ♀; Piacoa, 2 ♂; Cantaura, 1 ♂; Babinas, 1 ♀.

E. c. alticola.—VENEZUELA: Mt. Auyan-tepui (1100 meters), 4 ♂; (Phelps Collection): Kabanayén (1200–1260 meters), 16 ♂ (including type), 7 ♀, 6 (?); Mt. Auyan-tepui (1100 meters), 1 ♂, 1 ♀; Cerro Perro (300 meters), 1 ♂.

Leptopogon amaurocephalus orinocensis, new subspecies

TYPE: From Santa Rosalía, lower Caura Valley, State of Bolívar, Venezuela; altitude 100 meters. No. 25825, Phelps Collection, Caracas. Adult male collected February 19, 1944, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Nearest to *L. a. amaurocephalus* of Brazil from which it differs by having a darker crown and slightly darker, less yellowish back. It differs from *L. a. peruvianus*, of eastern Colombia to Bolivia, by having a paler breast, more yellowish gray, with less olivaceous wash.

RANGE: The type locality, between the

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXXVI" (1941, Amer. Mus. Novitates, no. 1108, pp. 14–15).

lower Caura and Cuchivero rivers, and the Apure River region against the foothills of the Andes from Acarigua to Santo Domingo, Táchira.

DESCRIPTION OF TYPE: Top of head near Mummy Brown, more olivaceous on nape; lores whitish with dusky tips to the feathers; back and uropygium Olive-Green; sides of head grayish olive, faintly streaked with whitish, merging into pale olivaceous gray on breast, sides, and flanks; abdomen light Chalcedony Yellow, under tail-coverts whiter. Wings Bone Brown; primaries, except outermost, narrowly, the secondaries and tertiaries broadly, edged externally with yellowish green; greater and median upper wing-coverts broadly edged terminally with pale buff forming two prominent bands; bend of wing Baryta Yellow; under wing-coverts and axillaries yellowish white; inner vanes of remiges narrowly edged with pale buff, basally on the more outer ones. Tail Bister, the rectrices, except the outermost, edged externally with yellowish green; shafts of rectrices dark brown on upper aspect, white on lower. Maxilla (in life) "black"; mandible "flesh, black tip"; feet "gray"; iris "sepia." Wing, 64 mm.; tail, 56; exposed culmen, 12; culmen from base, 15; tarsus, 14.

REMARKS: Sexes alike in coloration, the female with wings and tail slightly shorter. Size similar to *L. a. peruvianus*. Range of measurements: five adult males: wing, 63–66 (64.6) mm.; tail, 55–58 (56.1); culmen from base, 14–15 (14.6); five adult females: wing, 61–62 (61.4); tail, 50–53 (51.7); culmen from base, 14–16 (14.9).

***Leptopogon amaurocephalus*
obscuritergum, new subspecies**

TYPE: From Mt. Auyan-tepui, State of Bolívar, Venezuela; altitude 1100 meters. No. 324580, American Museum of Natural History. Adult male collected February 6, 1938, by E. Thomas Gilliard.

DIAGNOSIS: Differs from all other known races by having a darker and duller green back. Nearest to *L. a. peruvianus* but with breast grayer, less yellowish olive, and abdomen, on average, lighter yellow.

RANGE: From the foot of Mt. Duida eastward through the upper Caura and

Paragua River valleys to Santa Elena, near Mt. Roraima, and thence northward to the region of Mts. Auyan-tepui and Ptari-tepui.

DESCRIPTION OF TYPE: Top of head deep Mummy Brown, more olivaceous posteriorly; lores whitish with dusky tips; back and uropygium dark Yellowish Olive; sides of head dusky olive, faintly streaked with whitish; chin grayish white; breast, sides, and flanks light grayish olive, paler on the throat which is faintly streaked with pale yellowish; abdomen and under tail-coverts Reed Yellow. Wings blackish brown; primaries, except outermost, narrowly, the secondaries and tertiaries broadly, edged externally with yellowish green; greater and median upper wing-coverts broadly edged terminally with light buff, forming two prominent bands; bend of wing pale yellowish, slightly buffy; under wing-coverts and axillaries yellowish white; inner vanes of remiges narrowly edged with pale buff, only basally on the more outer ones. Tail dark Olive-Brown, the rectrices, except outermost, edged externally with yellowish green; shafts of rectrices dark brown on upper aspect, white on lower. Bill (in dried skin) black with a pale area at base of mandible; feet blackish brown. Wing, 69 mm.; tail, 58; exposed culmen, 12.5; culmen from base, 15; tarsus, 15.

REMARKS: Sexes alike in coloration, the female with wings and tail slightly shorter. Size similar to *peruvianus* and *orinocensis*. Range of measurements: five adult males: wing, 66–69 (67.5) mm.; tail, 54–58 (56.3); culmen from base, 14–16 (15); four adult females: wing, 61–64 (63.5); tail, 51–55 (52.7); culmen from base, 14.5–17 (15.5).

SPECIMENS EXAMINED

L. a. amaurocephalus.—BRAZIL¹: 21. PARAGUAY¹: 2. BOLIVIA¹: 4.

L. a. peruvianus.—BOLIVIA¹: 3. PERÚ¹: 3. COLOMBIA¹: 2. VENEZUELA (Phelps Collection), La Fría, 1 ♂.

L. a. obscuritergum.—VENEZUELA: Mt. Duida, Caño Seco, 1 ♂, 1 ♀, 1 (?) ; Mt. Auyan-tepui, 3 ♂ (including type), 2 (?) ; (Phelps Collection): Mt. Auyan-tepui, 1 ♀; Mt. Ptari-tepui, 1 (?) ; Kabanayén, 1 ♂, 1 (?) ; Río

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXXVIII" (1941, Amer. Mus. Novitates, no. 1126, pp. 6–7).

Caruai, 1 ♀; Salto Guaiquinima, 1 ♂; Comején Camp, 4 ♂, 1 ♀; Salto María Espuma, 1 ♂, 2 (?); Salto Maiza, 1 ♂; Santa Elena, Gran Sabana, 2 ♂, 1 ♀; Kabadisocaña, 1 (?).

L. a. orinocensis.—VENEZUELA (Phelps Collection): Santa Rosalia, Bolívar, 3 ♂ (including type); Acarigua, 1 ♂; La Veguita, 1 ♀; Barinitas, 2 ♀; Santa Bárbara, Barinas, 1 ♀; Santo Domingo, Táchira, 2 ♂, 1 ♀, 1 (?).

L. a. diversus.—COLOMBIA¹: 9.

L. a. faustus.—PANAMÁ¹: 8.

L. a. pileatus.—GUATEMALA¹: 3.

Pipromorpha oleaginea intensa, new subspecies

TYPE: From Salto Maiza, upper Paragua River, State of Bolívar, Venezuela; altitude 320 meters. No. 30453, Phelps Collection, Caracas. Adult male collected by Fulvio Benedetti, March 10, 1945. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Deeper, more orange ochraceous below than any other race of *P. oleaginea*.

RANGE: The upper Caura and upper Paragua River valleys, and at Paruima Mission on the Kamarang River in British Guiana.

DESCRIPTION OF TYPE: Top of head, back, and rump Roman Green; upper tail-coverts paler; sides of head more grayish. Abdomen Yellow Ocher × Ochraceous-Tawny; breast darker and browner; throat and chin more olivaceous, approaching Olive Lake. Wings Clove Brown; primaries and secondaries, except outermost, narrowly edged externally with yellowish olive, with an orange tinge distally; tertiaries with paler and wider terminal edgings, forming an elongated spot on each feather; greater and lesser wing-coverts edged and tipped with buff forming two indistinct bands; bend of wing chamois; under wing-coverts Orange-Buff; inner webs of remiges with buffy edgings, except terminally. Tail Olive Brown, the rectrices edged externally with greenish. Maxilla (in life) "black"; mandible "flesh color, black tip"; feet "gray"; iris "brown." Wing, 63 mm.; tail, 49.5; exposed culmen, 11; culmen from base, 13; tarsus, 15.5.

REMARKS: Sexes alike. Size similar to

P. o. chloronota. Range of measurements: five adult males: wing, 63–66 (63.8) mm.; tail, 48.5–50 (49.3); culmen from base, 13–14 (13.2); five adult females: wing, 57–64.5 (61.3); tail, 43–48 (46); culmen from base, 12.5–14 (13.2).

SPECIMENS EXAMINED

P. o. oleaginea.—BRAZIL²: 1.

P. o. chloronota.—BOLIVIA²: 3. BRAZIL²: 42. COLOMBIA²: 10. VENEZUELA: Caño Seco, Mt. Duida, 4 ♂; Sabana Grande, 1 ♂; Valle de los Monos, 1 ♂; Campamento del Medio, 2 ♂; Pie del Cerro, 1 ♂; Playa del Río Base, 3 ♂, 1 ♀; Esmeralda, 4 ♂; foot of Mt. Duida, 1 ♂, 1 ♀; Solano, 1 ♂, 1 ♀; Buena Vista, 7 ♂; El Meroy, 1 ♀; mouth of Río Ocamo, 2 ♀; Río Guainía, junction with the Casiquiare, 1 ♀, 2 (?); Nericagua, 1 ♂; Suapure, Río Caura, 5 ♂; Río Nichare, 3 ♀; La Unión, 1 ♂, 2 ♀; La Prisión, 1 ♂; (Phelps Collection): Sanariapo, 1 ♂; Caño Cataniapo, 4 ♂; Barinitas, 1 ♀; Ciudad Bolivia, 2 ♂, 1 ♀; Santa Bárbara, Barinas, 1 (?); Santo Domingo, Táchira, 1 ♂, 2 ♀.

P. o. huxwelli.—ECUADOR²: 28. PERÚ²: 10.

P. o. maymana.—PERÚ²: 19.

P. o. pacifica.—ECUADOR²: 17.

P. o. wallacei.—BRAZIL²: 46. FRENCH GUIANA²: 2. DUTCH GUIANA²: 8. BRITISH GUIANA²: 6.

P. o. intensa.—VENEZUELA (Phelps Collection): Campamento Comején, Río Paragua, 2 ♂; Salto María Espuma, 2 ♂, 2 (?); Salto Maiza, 3 ♂ (including type), 2 ♀, 3 (?); Salto El Payaso, Caño Antabari, 1 ♀, 1 (?); Raudal Capuri, Caño Antabari, 2 ♀, 3 (?); Raudal Caranca, Río Carún, 1 (?); Río Arawa, upper Río Caura, 1 ♂; Sabana Canaracuni, 1 ♂, 1 ♀; Chajuraña, 1 (?). BRITISH GUIANA (Phelps Collection): Paruima Mission, Kamarang River, 1 ♀.

P. o. pallidiventris.—VENEZUELA²: 28. TRINIDAD²: 14. TOBAGO²: 1.

P. o. parca.—VENEZUELA (Phelps Collection): La Fría, 3 ♂, 1 (?); El Vigía, 2 ♂, 2 ♀; La Sierra, 2 ♂, 1 (?); La Sabana, 1 ♂. COLOMBIA²: 40. PANAMÁ²: 13.

P. o. lutescens.—PANAMÁ²: 27.

P. o. dyscola.—PANAMÁ²: 24.

P. o. assimilis.—COSTA RICA²: 10. NICARAGUA²: 14. GUATEMALA²: 53. MÉXICO²: 4.

Microcerculus ustulatus lunatipectus, new subspecies

TYPE: From Mt. Guaiquinima (north-western slope), Paragua River, State of Bolívar, Venezuela; altitude 1300 meters. No. 28919, Phelps Collection, Caracas. Adult male collected January 30, 1945, by

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XXXVIII" (1941, Amer. Mus. Novitates, no. 1126, pp. 6–7).

² For list of localities, see Zimmer (*ibid.*, pp. 13–14).

Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Differs from the other known races of the species by having more prominent squamulations below, which extend forward over the breast and invade the throat. Differs also from *M. u. ustulatus*, from Mt. Roraima, in being less rufous, more brownish above, and grayer, less buffy rufous below. Differs also from *M. u. duidae* by being darker brownish above, with less yellowish tinge. Differs also from the Mt. Ptari-tepui population (described below as new) by being much lighter above and more grayish, less buffy, below.

RANGE: Known only from the northwestern slope of Mt. Guaiquinima at altitudes from 1200 to 1540 meters.

DESCRIPTION OF TYPE: Above near Cinnamon-Brown, more rufous on the upper tail-coverts; feathers of forehead and crown with dusky edges and centers giving a faint squamulated appearance; feathers of back very faintly and narrowly edged with dusky; lores and sides of head grayish brown with dusky tips. Chin and throat buffy white, the feathers with small dusky shaft spots giving a slightly mottled appearance; breast and abdomen darker, more buffy, with pronounced black subterminal bands or lunules across the feathers, most pronounced on the abdomen, giving a strongly squamulated appearance; sides and flanks olive brown, shanks darker; under tail-coverts bright brown finely red barred with black. Wings blackish brown, the outer webs of primaries finely edged with warmer brown and those of the secondaries and tertials deeply fringed with rufous darker than the back; greater and lesser wing-coverts edged with brown uniform with the back and with slight suggestions of dusky bars; under wing-coverts dusky. Tail brown, finely barred on the upper aspect with dusky. Maxilla (in life) "black"; mandible "horn-color"; feet "black"; iris "dark." Wing, 59 mm.; tail, 30; exposed culmen, 15; culmen from base, 20; tarsus, 26.

REMARKS: Sexes alike in coloration, female slightly smaller. Young much darker, near Auburn above and Ochraceous-Tawny below, lighter on throat, with the black

squamulations above much more prominent. Range of measurements: five adult males: wing, 58–62 (59.8) mm.; tail, 29–32 (30); culmen from base, 19–21 (19.9); five adult females: wing, 54–56.5 (55.2); tail, 27–30 (28); culmen from base, 18.5–19.5 (18.9).

Microcerculus ustulatus obscurus,
new subspecies

TYPE: From Mt. Ptari-tepui, Gran Sabana, State of Bolívar, Venezuela, altitude 1800 meters. No. 27504, Phelps Collection, Caracas. Adult male collected August 4, 1944, by Fulvio Benedetti. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Differs from the other known races of the species by having a much darker back—dark rufous—and more rufous under parts; differs also from *M. s. duidae* and from *M. s. lunatipectus* by lacking, in the adult, any squamulations on the under parts, or at most having only indications on the abdomen.

RANGE: Known only from the southwestern slope of Mt. Ptari-tepui, and from nearby Mt. Sororopán-tepui, at altitudes from 1300 to 2000 meters.

DESCRIPTION OF TYPE: Back and uropygium dark Auburn; crown and forehead slightly lighter, the feathers of crown with fine dusky tips giving a faint squamulated appearance; lores and side of head pale brown. Chin and anterior throat Saccardo's Umber merging into the light Cinnamon-Brown of breast and abdomen; belly with only faint suggestions of darker markings; sides, flanks, and under tail-coverts dark Argus Brown. Remiges blackish brown, with outer margins dark Chestnut-Brown, becoming lighter on the secondaries and tertials where it more nearly matches the back; upper wing-coverts with outer margins and tips the color of the back and with faint suggestions of dusky bars; under wing-coverts dusky. Tail dark rufous brown, much paler on the under aspect, with very faint dusky bars on the upper aspect especially on the more external rectrices. Maxilla (in life) "black"; mandible "yellow, black tip"; feet "slate"; iris "brown." Wing, 58 mm.; tail, 28;

exposed culmen, 15; culmen from base, 19; tarsus, 25.

REMARKS: Sexes alike in coloration. Female slightly smaller. Young heavily squamulated or barred with black throughout head and body plumage. Range of measurements: six adult males: wing, 58-60 (58.8) mm.; tail, 26-31 (28.8); culmen from base, 19-20 (19.3); five adult females: wing, 54-57 (55.4); tail, 25.5-27.5 (26.5); culmen from base, 17-19 (18.1).

It is notable that of the five great isolated table-topped mountains which have been explored and from which collections have been made—Mts. Roraima, Duida, Ptari-tepui, Guaiquinima, and Auyan-tepui—each of the first four has an endemic race of *M. ustulatus*, while on Mt. Auyan-tepui the species was not encountered. The last mountain lies midway between Mts. Ptari-tepui and Guaiquinima and is within sight of both.

SPECIMENS EXAMINED

M. u. ustulatus.—VENEZUELA: Roraima, 1 ♂ [juv.]; (Phelps Collection): Arapupú, 2 ♂.

M. u. duidae.—VENEZUELA: Mt. Duida (1000-1500 meters), 4 ♂ (including type), 3 ♀, 1 (?).

M. u. lunatipectus.—VENEZUELA (Phelps Collection): Mt. Guaiquinima (1200-1540 meters), 17 ♂ (including type), 9 ♀, 8 (?), 1 (?) [juv.].

M. u. obscurus.—VENEZUELA (Phelps Collection): Mt. Ptari-tepui (1300-2000 meters), 15 ♂ (including type), 8 ♀, 6 ♂ [juv.], 1 ♀ [juv.], 2 (?) , 4 (?) [juv.]; Mt. Sororopán-tepui, 1 ♂, 1 (?) , 1 (?) [juv.].

Leucolepis arada urbanoi, new subspecies

TYPE: From Caruai River, near Mt. Ptari-tepui, Gran Sabana, State of Bolívar, Venezuela; altitude 1000 meters. No. 28044, Phelps Collection, Caracas. Adult male collected August 28, 1944, by Ramón Urbano. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Nearest to *L. a. arada* from which it differs by being less rufous, more olivaceous, on back and flanks, more whitish on the abdomen.

RANGE: Known only from the upper Tropical Zone in the forests near the base of Mt. Ptari-tepui at Kabanayén and the Caruai River, and on the Altiplanicie de Nuria in the Imataca Mountains.

DESCRIPTION OF TYPE: Crown and nape Argus Brown × Auburn, merging into the Sanford's Brown × Burnt Sienna of forehead and lores; anterior part of mantle and sides of neck black with prominent white shaft streaks; middle and lower back and uropygium dark Prout's Brown; a whitish supra-auricular stripe (edged with black) from the eye to the black and white collar; auriculars Hazel. Chin and throat Sanford's Brown × Hazel, paler on the chest; abdomen buffy whitish merging into the Mummy Brown sides, flanks, and shanks; under tail-coverts brighter, barred with dusky. Wings Fuscous; exposed outer portions of remiges and all the upper coverts brighter brown, narrowly barred with dusky; under wing-coverts grayish buffy. Tail pale Prout's Brown, the rectrices finely barred with black, less distinct on the under aspect. Bill (in life) "black, the base grayish"; feet "brownish-black"; iris "brown." Wing, 64 mm.; tail, 33; exposed culmen, 16; culmen from base, 19; tarsus, 23.

REMARKS: Sexes alike. Size similar to *L. a. arada*. Range of measurements: four adult males: wing, 61-64 (62.2) mm.; tail, 30-34 (32.2); culmen from base, 19-19.5 (19.2); one adult female: wing, 61; tail, 32; culmen from base, 18; one of undetermined sex: wing, 64.5; culmen from base, 19.

This new race has been named in honor of Señor Ramón Urbano, the collector.

Leucolepis arada faroensis, new subspecies

TYPE: From Faro (Castanhal), Rio Jamundá, north bank of the Amazon River, Brazil. No. 284565, American Museum of Natural History. Adult male collected January 3, 1931, by the Olalla brothers.

DIAGNOSIS: Back distinctly paler than in *L. a. arada*; crown usually paler; abdomen whiter. Differs from all other known races of the species except *arada* by having a black and white collar.

RANGE: The region of Faro and Obidos on the north bank of the Amazon River.

DESCRIPTION OF TYPE: Crown and nape dark Auburn, merging into the Sanford's Brown of the forehead; crown with con-

cealed pale bases and shaft stripes; anterior part of mantle and sides of neck black with prominent wide shaft streaks; middle and lower back and uropygium Dresden Brown $\times$ Raw Umber; a whitish supra-auricular stripe (edged with black) from the eye to the black and white collar; auriculars Hazel. Chin, throat, and breast deep Sanford's Brown; abdomen buffy whitish merging into the Cinnamon-Brown sides, flanks, and shanks; under tail-coverts brighter, faintly barred with dusky. Tail Raw Umber $\times$ Brussels Brown, the rectrices finely barred with black. Bill (in dried skin) black, under surface of mandible pale; feet brown. Wing, 61 mm.; tail, 34; exposed culmen, 14.5; culmen from base, 19.5; tarsus, 22.

REMARKS: Sexes alike. Size similar to *L. a. arada*. Range of measurements: three adult males: wing, 61–63 (61.7) mm.; tail, 32–34 (32.7); culmen from base, 19.5–20 (19.8); four adult females: wing, 60–62 (60.7); tail, 31; culmen from base, 19.5–20.5 (20).

According to Hellmayr,¹ *L. a. arada* reaches the Amazon at Manáos, to the west of the range of this new form. He says, "There is no difference whatever between specimens from French and British Guiana and others from Manáos." Geographically the Manáos birds should show closer relationship to those from Faro than to the Guianan population, but in the absence of material from Manáos we must accept Hellmayr's assignment.

SPECIMENS EXAMINED

L. a. urbanoi.—VENEZUELA (PHELPS COLLECTION): Río Caruái (1000 meters), foot of Mt. Pari-tepui, 1 ♂, 1 ♀, 1 (?); Kabanayén (1000 meters), 1 ♂ (type); Altiplanicie de Nuria (460 meters), 2 ♂.

L. a. arada.—FRENCH GUIANA: Tamanoir, 3 ♂, 1 ♀; "Cayenne," 2 (?). BRITISH GUIANA: Potaro Landing, 1 ♂, 1 ♀; Tumatumari, 2 ♂; Kamakusa, 4 ♂, 2 ♂ juv., 4 ♀, 2 ♀ juv.; Kamarang River, 1 ♂; Meamu (mouth), 1 ♂. VENEZUELA (PHELPS COLLECTION): Arabupú, 1 ♂, 1 ♀.

L. a. faroensis.—BRAZIL: Faro (Castanhal), Río Jamundá, 1 ♂ (type), 3 ♀; Faro (San José), Río Jamundá, 1 ♂; Obidos, 1 ♂, 1 ♀.

L. a. griseolateralis.—BRAZIL: Aramanay, Río Tapajoz, 1 ♂; Caxiricatuba, 1 ♀.

L. a. interposita.—BRAZIL: Villa Bella Imperatriz, 1 ♂; Río Roosevelt, 1 ♀; Calamá, 3 ♂, 2 ♀.

L. a. modulatrix.—BOLIVIA: Todos Santos, Cochabamba, 1 ♀.

L. a. rufogularis.—PERÚ: Lagarto, 1 ♂; Sarayacu, 1 ♀. BRAZIL: Tefé, 1 ♂, 1 ♀, 1 (?).

L. a. rutilans.—PERÚ: Río Távora, 1 (?); La Pampa, 2 ♀.

L. a. transfluvialis.—BRAZIL: Igarapé Cação Pereira, Río Negro, 1 ♂, 1 ♀. COLOMBIA: Florencia, 3 ♂.

L. a. salvinii.—ECUADOR: Río Suno, above Avila, 3 ♂, 3 ♀; lower Río Suno, 1 ♂, 3 ♀; Zamora, 2 ♂; below San José, 2 ♂, 3 ♀; Boca Lagarto Cocha, 2 ♀; Napo, 1 (?). PERÚ: mouth of Río Curaray, 1 ♂, 1 ♀.

Coereba flaveola bolivari, new subspecies

TYPE: From Ciudad Bolívar, State of Bolívar, Venezuela. No. 507901, American Museum of Natural History. Adult male collected November 30, 1898, by Samuel M. Klages.

DIAGNOSIS: Nearest to *C. f. luteola* of northern Venezuela but back paler, brownish gray instead of dark brownish black, and the crown less deeply black.

RANGE: South bank of the Orinoco River from Ciudad Bolívar eastward to Manoa and from thence southward to the region of the lower Paragua and Yuruari rivers.

DESCRIPTION OF TYPE: Forehead, crown, lores, and sides of head Fuscous-Black; back Chaetura Drab; rump Strontian Yellow; upper tail-coverts uniform with the back; a white superciliary stripe from near the base of the bill to the neck. Chin and throat Pale Mouse Gray; breast and abdomen deep Strontian Yellow, more whitish towards the vent; an olivaceous wash on sides and flanks; under tail-coverts white. Wings Fuscous; primaries and secondaries very narrowly edged with white on outer webs; a very prominent white speculum on the second to sixth primaries (from outside); bend of wing yellowish; under wing-coverts white; inner webs of remiges white basally, this extending distad on inner margins. Tail Fuscous, but median rectrices approaching the color of the back; outer two rectrices broadly

¹ "Catalogue of birds of the Americas, etc." (1934, Field Mus. Nat. Hist., zool. ser., vol. 13, pt. 7, p. 289).

tipped with white on the inner vanes and with indications of white on the very tips of the third and fourth. Bill (in dried skin) black; feet dark brown. Wing, 58.5 mm.; tail, 33; exposed culmen, 12; culmen from base, 15; tarsus, 16.

REMARKS: Sexes similar. The young are paler above and below, with a yellowish superciliary stripe. Size similar to *C. f. luteola*. Range of measurements: five adult males: wing, 54–59 (57.3) mm.; tail, 31.5–34 (32.8); culmen from base, 15–16 (15.3); five adult females: wing, 53–56.5 (54.3); tail, 28.5–33 (30.7); culmen from base, 15–15.5 (15.1).

The name *major* Cabanis, which has been synonymized with *luteola*, was given to a "Guiana" specimen. It is not known whence the specimen really came, but it could not have been from the lower Orinoco River as the original description does not fit the new race from Ciudad Bolívar.

The five specimens of *luteola* from Altigracia and Caicara are similar to the topotypical series from Puerto Cabello. This shows that the black-backed northern race crosses the Orinoco River to the west of the Caura River. Between this place and the range of the new race, *C. f. guianensis*, without the white speculum, inhabits the lower Caura River.

SPECIMENS EXAMINED

C. f. chloropyga.—BRAZIL¹: 236.
C. f. dispar.—BOLIVIA¹: 6.
C. f. allenii.—BRAZIL¹: 54.
C. f. minima.—VENEZUELA: Río Casiquiare (Buena Vista and Solano), 21. DUTCH GUIANA: 10. FRENCH GUIANA: 7. BRAZIL¹: 42.
C. f. guianensis.—VENEZUELA: Río Caura (Suapure, La Prisión, and La Unión), 9.
C. f. roraimae.—VENEZUELA: Mt. Duida, 4; Mt. Auyan-tepui, 1; Roraima, 5.
C. f. luteola.—COLOMBIA: Cartagena, 1 (?); Simu River, 1 ♂; La Playa, 1 ♂, 2 ♂ [juv.]; Santa Marta region, 3 ♂, 1 ♀, 3 (?). VENEZUELA: Tucacas, 4 ♂, 1 ♀; El Cují, 1 ♂; Las Trincheras, 1 ♂; San Esteban, 1 (?); Cotiza, 1 ♂, 2 ♀ juv.; Caracas, 1 ♂; El Limón, D. F., 2 ♂, 1 ♀; Cumaná, 1 ♂, 1 ♀; Quebrada Seca 2 ♂, 1 ♀; Rincón de San Antonio, 2 ♂, 1 ♀, 1 ♀ [juv.]; Cumanacoa, 2 ♂; Cuchivano, 1 ♂, 1 ♀; La Florida, 1 ♂; Cocollar, 1 ♀; San Antonio, 1 ♂ [juv.]; Cristóbal Colón, 2 ♂, 1 ♀ [juv.], 2 ♀ [juv.]; Altigracia,

3 ♂, 2 ♂ [juv.], 1 (?); Caicara, 1 ♂; Margarita Island, 2 ♂, 1 ♀; (Phelps Collection): Puerto Cabello, 5 ♂, 2 ♀, 1 (?); Los Altos, 1 ♂, 1 ♀; Quebrada Bonita, 1 ♂, 1 ♀; Margarita Island, 5 ♂, 3 ♀.

C. f. boliviari.—VENEZUELA: Ciudad Bolívar, 6 ♂ (including type), 1 ♂ juv.; Agua Salada de Ciudad Bolívar, 1 ♂; (Phelps Collection): Ciudad Bolívar, 2 ♂, 2 ♀, 2 (?); San Félix, Bolívar, 1 ♂; Manoa, 2 ♂; El Palmar, 1 ♂, 1 ♀; Guasipati, 1 ♂; Cerro Tigre, 4 ♂, 2 ♀, 1 (?); La Paragua, 5 ♂, 2 ♀.

C. f. montana.—VENEZUELA: Mérida region, 27.

C. f. columbiana.—VENEZUELA: Puerto Ayacucho, 2 ♂, 4 ♀, 1 (?). COLOMBIA: 35. PANAMÁ¹: 11.

C. f. cerinoclunis.—PANAMÁ: Pearl Islands, 12.

C. f. intermedia.—VENEZUELA: Río Casiquiare (junction with Río Guainía), 22. PERÚ¹: 13. ECUADOR: 83. COLOMBIA¹: 7. BRAZIL¹: 3.

C. f. magnirostris.—PERÚ¹: 28.

C. f. pacifica.—PERÚ¹: 8.

C. f. gorgonae.—COLOMBIA: Gorgona Island, 1 ♂, 1 ♀.

C. f. caucae.—COLOMBIA¹: 8.

C. f. mexicana.—PANAMÁ: 34. COSTA RICA: 8. GUATEMALA: 24. NICARAGUA: 4.

C. f. ferryi.—VENEZUELA: Tortuga Island, 1 (?).

C. f. uropygialis.—CURAÇAO ISLAND: 21. BONAIRE ISLAND: 6. ARUBA ISLAND: 3.

C. f. laurae.—VENEZUELA: Los Testigos Island, 8.

C. f. aterrima.—GRENADA: 1. GRENADINES: 1.

C. f. atrata.—ST. VINCENT: 11.

C. f. barbadensis.—BARBADOS: 5.

C. f. martinicana.—MARTINIQUE: 6. SANTA LUCIA: 26.

C. f. bartholemica.—ST. BARTHOLOMEW: 3. ST. EUSTATIUS: 1. DOMINICA: 17. GUADELOUPE: 10. BARBUDA: 5. ANTIGUA: 7.

C. f. newtoni.—ST. CROIX: 6.

C. f. sancti-thomae.—ST. THOMAS: 16.

C. f. portoricensis.—PUERTO RICO: 18. VIEQUES ISLAND: 4.

C. f. bananivora.—SANTO DOMINGO: 41. HAITI: 3.

C. f. flaveola.—JAMAICA: 19.

C. f. bahamensis.—BAHAMAS: 26.

C. f. sharpei.—GRAND CAYMAN: 8.

C. f. tricolor.—OLD PROVIDENCE ISLAND: 3.

C. f. obliqua.—ST. ANDREWS ISLAND: 1.

C. f. caboti.—COZUMEL ISLAND: 4.

Atlapietes semirufus albigula, new subspecies

TYPE: From Seboruco, State of Táchira, Venezuela; altitude 1300 meters. No. 28694, Phelps Collection, Caracas. Adult male, collected December 14, 1944,

¹ For list of localities, see Zimmer, "Studies of Peruvian birds. No. XLIII" (1942, Amer. Mus. Novitates, no. 1193, pp. 9–10).

by Ramón Urbano. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Differs from all other known races of *A. semirufus* by having a white center of the throat, almost white chin, and cinnamon-colored sides of head and throat.

RANGE: Known only from the type locality at altitudes of 1200 and 1300 meters.

DESCRIPTION OF TYPE: Crown and nape Tawny (× Ochraceous-Tawny); back and uropygium nearest to dark Serpentine Green; sides of head and malar region Cinnamon × Orange-Cinnamon. Chin whitish cinnamon; center of throat white; breast and abdomen deep Lemon Yellow; flanks yellowish olive; shanks olive; under tail-coverts olive edged with yellowish. Wings Fuscous-Black; outer primary narrowly edged with white on outer web; other primaries narrowly edged with gray terminally and greenish gray basally; tertials and greater upper wing-coverts heavily edged, and median and lesser coverts heavily tipped, with green on outer webs, uniform with the back; shafts black on upper aspect; under side of tail grayer with shafts white. Maxilla (in life) "black"; mandible "brown"; feet "brownish-black"; iris "brownish-chestnut." Wing, 75 mm.; tail, 81; exposed culmen, 14; culmen from base, 17; tarsus, 27.

REMARKS: Sexes alike in coloration.

Females smaller; measurements: wing, 69, 69.5 mm.; tail, 72, 74; exposed culmen, 14, 14; culmen from base, 17, 17; tarsus, 25, 26.

This is the most distinctively marked of all the races of *A. semirufus*. When the first specimen was collected in 1940 it was not described for fear that it might have been partially albinistic or a sport. Four years later one of the collectors of the Phelps Collection, Ramón Urbano, was sent on a special trip to this same locality to try to get additional specimens to solve the problem, and he was successful.

The type locality is on the Maracaibo Lake side of the main mountain chain of the Venezuelan Andes, while on the Orinoco River watershed side, at similar altitudes, *A. s. majusculus* occurs at Queniquea. The two ranges are separated by a "páramo" 2500 meters high.

SPECIMENS EXAMINED

*A. s. semirufus*¹.—COLOMBIA: 16.

*A. s. majusculus*¹.—COLOMBIA: 9. VENEZUELA (Phelps Collection): 17.

A. s. albicula.—VENEZUELA (Phelps Collection): Seboruco, 1 ♂ (type), 2 ♀.

*A. s. benedetti*¹.—VENEZUELA (Phelps Collection): 12.

*A. s. denisei*¹.—VENEZUELA: 25.

¹ For full list of localities, see Phelps and Gilliard, "Seventeen new birds from Venezuela" (1941, Amer. Mus. Novitates, no. 1153, p. 16).

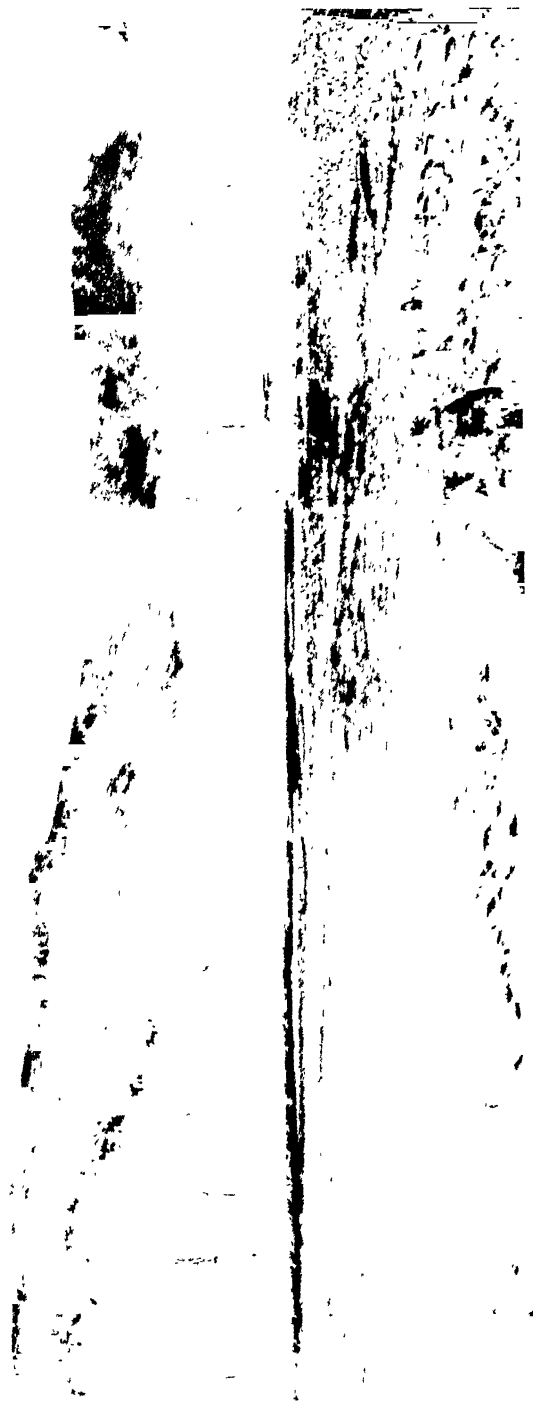


Fig 1 Mt Guacunuma, looking east from Guacunuma Falls on the Paragua River

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REPORT ON A COLLECTION OF SPIDERS FROM MEXICO. V

BY W. J. GERTSCH AND L. IRBY DAVIS

This is the fifth in the series of papers under the above title and is concerned with the larger members of the sheet-web weavers of the family Linyphiidae. Most of the species have proved to be undescribed, and relatively few are identical with those delineated by the Cambridges in the "Biologia Centrali-Americana." Representatives of two new genera are in the material. One of them, *Selenyphantes*, is based on a previously described species from Guatemala, placed by O. P.-Cambridge in *Lepthyphantes*. In the second genus, *Jalapyphantes*, are placed three well-marked but closely allied species.

Our sincere thanks are due to the individuals who have contributed material to this collection. Proper credit is given to each collector responsible for securing the specimens noted in the various records. At this time the authors wish to acknowledge the receipt of some very important collections from many parts of Mexico, placed in our custody, from Drs. Frederico Bonet and C. Bolivar Pieltain of Mexico City. An increasing number of records from this material will be published in this series and in other papers dealing with the Mexican fauna.

The types of the new species are deposited in the collection of the American Museum of Natural History. Paratypes and duplicates of known species will be placed in the personal collections of Drs. Bonet and Bolivar.

GENUS *FRONTINELLA* F. CAMBRIDGE

Frontinella F. CAMBRIDGE, 1902, *Biologia Centrali-Americana*, Arachnida, vol. 2, p. 420. (Genotype, *Frontinella laeta* Cambridge.)

Several fine species of this interesting genus are represented in the collection, but only one of them is identical with those named by F. O. P.-Cambridge. It is no-

table that the males of the three new species herein described all have the patella of the palpus set with a long dorsal spine. In all the other known species this spine is modified into a short spur.

Frontinella pyramitela Walckenaer

Linyphia pyramitela WALCKENAER, 1841, *Histoire naturelle des insectes. Aptères*, vol. 2, p. 261.

Linyphia communis HENTZ, 1850, *Jour. Boston Soc. Nat. Hist.*, p. 28, pl. 4, fig. 4.

Frontinella communis F. CAMBRIDGE, 1902, *Biologia Centrali-Americana*, Arachnida, vol. 2, p. 422; BLAUVELT, 1936, *Festschrift Embrik Strand, Riga*, vol. 2, pp. 145-149, pl. 13, figs. 90-94, pl. 14, fig. 95.

It seems quite probable that *Frontinella rustica* F. Cambridge, based on a female from Orizaba, Mexico, represents this abundant, widespread species.

RECORDS: Tamaulipas: Hacienda San Rafael, 6 miles east of Villa Juarez, July 7, 1941, three females (L. I. Davis); 14 miles south of Villa Juarez, April 12, 1941, two females (A. M. Davis); 8 miles north of Victoria, April 13, 1941, two females (A. M. Davis); Rio Guayalejo, near Forlon, April 16, 1938, one female (L. I. Davis and Bryce Brown); 2 miles east of Nuevo Morelos, December 2, 1939, two females (A. M. Davis); Rio Frio at Limon, April 18, 1938, two females (L. I. Davis); 7 miles south of Hidalgo, July 3, 1936, one female (L. I. Davis); Sierra de Tamaulipas, 2700 feet, August 4-7, 1945, two females (H. Wagner). Nuevo Leon: Linares, July 8, 1941, two females (L. I. Davis); Monterrey, June 10, 1936, one female (L. I. Davis); 10 miles west of Cadereyta, July 6, 1936, one female (L. I. Davis); San Luis Potosi: Arroyo Calabaza, 21 miles south of Valles, November 30, 1940, one female (A. M. Davis); 24 miles south of Valles, April 12, 1941, three females (A. M.

Davis); 4 miles south of Valles, March 23, 1940, females (M. B. Bishop); Tamazunchale, July 6-7, 1941, one male, two females (L. I. Davis); 20 miles east of Ciudad del Mais, March 23, 1940, three females (A. M. and L. I. Davis); Xilitla, December 2, 1939, female (L. I. Davis). Distrito Federal: Pedregales, August, 1909, one male, one female (A. Petrunkevitch). Sonora: 27 miles south of Nogales, June 15, 1939, two females (A. M. and L. I. Davis). Puebla: 7 miles south of Tlacotepec, June 24, 1936, one female (A. M. and L. I. Davis); Riofrio, 3000 meters, April 26, 1942, one male (C. Bolivar, B. Osorio, D. Peláez); Tehuacan, October 17-24, 1944, males and females (H. Wagner). Vera Cruz: Cordoba, 1909, one female (A. Petrunkevitch). Morelos: Tequesquitengo, July 4-11, 1944, female (H. Wagner).

Frontinella huachuca, new species

Figures 4 and 5

FEMALE: Total length, 4.75 mm. Carapace, 2.00 mm. long; 1.40 mm. wide. Abdomen, 2.70 mm. long; 1.75 mm. wide.

Carapace pale yellowish brown, the pars thoracica faintly marked with dusky radiating lines, the clothing a very sparse covering of inconspicuous short hairs. Eye tubercles black. Sternum and venter of the abdomen brown. Coxae and legs pale yellowish brown without markings. Dorsum of abdomen creamy white, medially marked with a narrow longitudinal darker streak from which radiate small darker lines. Sides of the abdomen creamy white but with five darker bands or streaks on each side. Spinnerets and area above anal tubercle brown.

Structure typical, in very close agreement with *pyramitela* and related species. Eye group occupying three-fifths of the width of the carapace. First row of eyes essentially straight as seen from in front but strongly recurved as seen from above, the median separated by less than their radius, a little more than a full diameter from the slightly larger lateral eyes. Posterior eye row moderately recurved, the median separated by two-thirds their diameter, nearly one and one-half diameters from the subequal lateral eyes. Lateral

eyes of each side contiguous, median ocular quadrangle longer than broad (30/25), narrowed in front (25/22), the front eyes a little smaller. Clypeus equal in height to two full diameters of the anterior median eyes. Chelicerae normal, the upper margin armed with six teeth, the lower with five. Sternum, 1.20 mm. long, 0.95 mm. wide, bluntly pointed between the posterior coxae which are separated by about one-half their width.

Legs of about normal length for the genus. First leg: femur, 3.00 mm.; patella, 0.70 mm.; tibia, 2.60 mm.; metatarsus, 3.00 mm.; tarsus, 1.50 mm. Tibia and patella of fourth leg, 2.35 mm.

Abdomen as high as wide, oval as seen from above, as high immediately above the spinnerets as at center, without pronounced caudal tubercle. Epigynum as shown in figure 5.

MALE: Total length, 4.10 mm. Carapace, 2.10 mm. long, 1.35 mm. wide. Abdomen, 2.20 mm. long, 1.00 mm. wide.

Coloration and general appearance essentially as in the female. Legs and carapace concolorous, light yellowish brown. Sternum and venter of the abdomen dark brown. Dorsum and sides of the abdomen grayish brown but with numerous white flecks.

Structure essentially as in the female. Eyes of the first row moderately recurved as seen from in front, the median separated by less than the radius, about a diameter and a half from the larger lateral eyes. Posterior row of eyes as in the female. Clypeus higher, equal in height to fully three diameters of the median eye. Median ocular quadrangle longer than broad as in the female and narrowed in front at about the same ratio. Chelicerae essentially as in the female, the lower margin with five teeth, the upper margin somewhat produced at tip of fangs into a low process which bears two moderately robust teeth, two smaller ones, and a small but robust tooth set above the other larger ones. Fang moderately incrassated at the middle. Chelicerae evenly covered with small pits from which originate short black hairs. Sternum, 1.10 mm. long, 0.80 mm. wide.

Legs as usual, longer than in the female,

set with a few stout hairs and very weak spines. First leg: femur, 2.75 mm.; patella, 0.60 mm.; tibia, 2.30 mm.; metatarsus, 3.00 mm.; tarsus, 1.40 mm. Tibia and patella of the fourth leg, 2.20 mm. long.

Palpus relatively short, set with short stiff hairs, the patella with a long, unmodified dorsal spine. Details of the lamella of palpus as illustrated in figure 4.

TYPE LOCALITY: Male holotype and female allotype from Bear Wallow, Santa Catalina Mountains, Arizona, July 12-15, 1940 (Gertsch and Hook).

RECORDS: Arizona: Madera Canyon, Santa Rita Mountains, June 24, 1939, two male and two female paratypes (A. M. and L. I. Davis); Huachuca Mountains, July 21, 1936, two female paratypes (Knull); Chiricahua Mountains, August 29, 1938, female paratype (R. H. Crandall).

***Frontinella huachuca benevola*,**

new subspecies

Figures 1, 2, and 3

The Mexican specimens considered here, which seem undoubtedly to belong to the species defined above, agree completely or nearly so in coloration and general structure with examples of *huachuca*. However, certain constant differences in the details of parts of the palpus, which is shown in figure 1, seem significant. In both forms the patella is provided with a long, fine spine which replaces the spur of all previously described species. The ventral aspect of the palpus presents a large lateral apophysis (lamella of the embolic division) which gives rise to a rather slender caudal spur and a long, slender, laterally directed element which curves across the tegulum and sweeps far beyond. Both of these spurs are somewhat differently formed, the caudal one especially being more slender than in *huachuca*, as can be seen by comparison with figure 4. The epigyna of the females also show some differences. In *benevola* the openings are somewhat nearer together and the caudal projection is not so prominent.

TYPE LOCALITY: Male holotype, female allotype, and paratypes from Horsetail Falls, Nuevo Leon, November 27, 1937 (L. I. Davis and Bryce Brown). Male

and female paratypes from same station, June 11, 1936 (A. M. and L. I. Davis). Male and female paratypes from Chimpingue, Monterrey, Nuevo Leon, July 15, 1942 (F. Bonet, B. Osorio, D. Peláez).

***Frontinella tibialis* F. Cambridge**

Frontinella tibialis F. CAMBRIDGE, 1902, Biologia Centrali-Americana, Arachnida, vol. 2, p. 422, pl. 40, figs. 7-76.

RECORDS: Vera Cruz: Potrero, June 24, 1936, one male (L. I. Davis).

***Frontinella potosia*, new species**

Figures 7, 8, and 9

FEMALE: Total length, 5.00 mm. Carapace, 1.80 mm. long, 1.20 mm. wide. Abdomen, 3.00 mm. long, 2.00 mm. wide.

Carapace yellowish brown, the pars thoracica lightly infuscated, the eye tubercles black. Chelicerae brown; sternum dusky brown. Legs dull yellowish brown, unmarked except for very narrow black rings at ends of all the joints, incomplete above. Abdomen mostly black as seen from above, margined with white flecks and with three white bands in the caudal half. The venter black, the sides black but with white bands in spots.

Structure typical, in close agreement with *pyramitela*. First row of eyes slightly recurved, the median separated by less than a radius, scarcely a full diameter from the larger lateral eyes. Posterior eye row moderately recurved, the median separated by two-thirds of the diameter, a full diameter from the equal lateral eyes. Median ocular quadrangle longer than broad (35/30), narrowed in front (30/25), the anterior eyes smaller. Clypeus equal in height to twice the diameter of the anterior median eyes. Chelicerae normal, the upper margin with six teeth, the lower with five. Sternum, 1.00 mm. long, 0.85 mm. wide, narrowed and rounded between the posterior coxae which are separated by one-half their width.

Legs of normal length, clothed thinly with fine hairs and a few very weak spines. First leg: femur, 2.75 mm.; patella, 1.15 mm.; tibia, 2.30 mm.; metatarsus, 2.60 mm.; tarsus, 1.35 mm. Tibia and patella of the fourth leg, 2.25 mm. long.

Abdomen oval as seen from above, nearly as high as broad, broadly truncate behind but without caudal tubercle. Epigynum as illustrated in figure 9.

MALE: Total length, 3.00 mm. Carapace, 1.40 mm. long, 0.97 mm. wide. Abdomen, 1.65 mm. long, 0.90 mm. wide.

Coloration essentially as in the female. Legs more brightly colored, especially the femora which are bright orange. Abdomen mostly dusky, the lighter silvery markings of the female inconspicuous.

Structure essentially as in the female. Eyes more closely grouped, first row moderately recurved, the median scarcely separated and only two-thirds their diameter from the larger lateral eyes. Posterior row of eyes moderately recurved, the median separated by two-thirds the diameter, almost a full diameter from the equal lateral eyes. Median ocular quadrangle longer than broad (30/26), narrowed in front (26/23), the eyes subequal in size, equal in height to two diameters of the anterior median eyes. Sternum, 0.80 mm. long, 0.65 mm. wide.

Legs of moderate length. First leg: femur, 2.10 mm.; patella, 0.40 mm.; tibia, 1.80 mm.; metatarsus, 2.00 mm.; tarsus, 1.10 mm. Tibia and patella of the fourth leg, 1.50 mm. long. Palpus as illustrated in figures 7 and 8.

TYPE LOCALITY: Male holotype, female allotype, and paratypes from 5 miles north of Tamazunchale, San Luis Potosi, Mexico, July 2, 1939 (A. M. and L. I. Davis).

RECORDS: San Luis Potosi: Male and female paratypes from Tamazunchale, Mexico, July 6-7, 1941 (L. I. Davis); female paratype, July 8, 1944 (L. I. Davis). Vera Cruz: Potrero, June 24, 1936, female paratype (L. I. Davis).

Frontinella caudata, new species

Figure 6

FEMALE: Total length, 6.50 mm. Carapace, 2.20 mm. long, 1.30 mm. wide. Abdomen, 4.00 mm. long, 2.30 mm. wide.

Carapace yellowish brown, lightly infuscated, the pars thoracica with the usual dusky radiating lines. Sternum and labium dark brown. Legs yellowish brown, somewhat dusky, the posterior femora and all

the coxae bright yellow. Abdomen black as seen from above, margined with a creamy white band which is complete around to the sides of the caudal tubercle; the venter black, the sides black but marked with creamy white spots and bars.

Structure in close agreement with *pyramitela* and *potosia*. First row of eyes moderately recurved, the median separated by their radius, about one and one-half diameters from the somewhat larger lateral eyes. Posterior row of eyes moderately recurved, the median separated by three-fourths their diameter, scarcely one and one-half diameters from the equal lateral eyes. Median ocular quadrangle longer than broad (35/30), narrowed in front (30, 24). Clypeus equal in height to two and one-half diameters of an anterior median eye. Chelicerae normal. Sternum, 1.20 mm. long, 0.90 mm. wide.

Legs of average length for the genus. First leg: femur, 3.25 mm.; patella, 0.70 mm.; tibia, 3.00 mm.; metatarsus, 3.60 mm.; tarsus, 1.70 mm. Tibia and patella of the fourth leg, 2.70 mm.

Abdomen oval as seen from above, about as high as broad, caudally elevated into a pronounced tubercle. Epigynum as illustrated in figure 6.

TYPE LOCALITY: Female holotype and female paratype from 39 miles south of Chilpancingo, Guerrero, Mexico, June 30, 1941 (L. I. Davis).

RECORDS: Chiapas: Mapastepec, March, 1941, female paratypes (H. Wagner); Tapachula, August, 1909, two female paratypes (A. Petrunkevitch).

Frontinella lepidula, new species

Figures 10 and 11

MALE: Total length, 3.40 mm. Carapace, 1.60 mm. long, 1.05 mm. wide. Abdomen, 1.70 mm. long, 0.90 mm. wide.

Coloration in close agreement with *huachuca*. Carapace and femora of legs bright orange brown, the distal joints of the legs dusky yellowish brown. Sternum and labium dark brown. Abdomen mostly gray above, the venter dusky.

Structure typical, essentially as in *huachuca*. First eye row moderately recurved, the median separated by about

their radius, slightly more than a diameter from the larger lateral eyes. Second row of eyes moderately recurved, the median separated by a full diameter, and more than a full diameter from the equal lateral eyes. Median ocular quadrangle slightly longer than broad (26/25), narrowed in front (25/20), the front eyes smaller. Clypeus equal in height to three diameters of an anterior median eye.

Legs of normal length for the genus. First leg: femur, 2.70 mm.; patella, 0.50 mm.; tibia, 2.10 mm.; metatarsus, 2.30 mm.; tarsus, 1.35 mm. long. Tibia and patella of the fourth leg, 2.20 mm. long.

Abdomen without caudal tubercle. Palpus as illustrated in figures 10 and 11.

TYPE LOCALITY: Male holotype from Tonalá, Chiapas, Mexico, August, 1909 (A. Petrunkevitch).

This is a smaller species than *tibialis* Cambridge. The embolus of the male palpus is shorter and less strongly curved at the apex, and the patella of the palpus is armed with a long curved spine instead of a short spur.

GENUS FLORINDA O. P.-CAMBRIDGE

Florinda O. P.-CAMBRIDGE, 1895, *Biologia Centrali-Americana*, Arachnida, vol. 1, pp. 164, 224. (Type, *Florinda mirifica* O. P.-Cambridge.)

Linyphiella BANKS, 1905, *Amer. Nat.*, vol. 39, p. 311. (Type, *Linyphiella coccinea* Hentz.)

Frontinella BLAUVELT (part), 1936, *Festschrift Embrik Strand*, Riga, vol. 2, p. 144.

The generic name *Florinda* antedates *Linyphiella* Banks and should be used for the well-known *Linyphia coccinea* of Hentz. Blauvelt placed the species in the genus *Frontinella*, but it is probable that *coccinea* is more closely related to, and perhaps should be kept in, the genus *Linyphia*.

Florinda coccinea Hentz

Linyphia coccinea HENTZ, 1850, *Jour. Boston Soc. Nat. Hist.*, vol. 6, p. 30, pl. 4, fig. 8.

Florinda mirifica O. P.-CAMBRIDGE, 1895, *Biologia Centrali-Americana*, Arachnida, vol. 1, pp. 164, 224, pl. 21, fig. 11.

Linyphiella coccinea BANKS, 1905, *Amer. Nat.*, vol. 39, p. 311; CHAMBERLIN AND IVIE, 1944, *Bull. Univ. Utah*, vol. 35, no. 9, p. 83.

RECORDS: Tamaulipas: Riofrio, at Limón, April 18, 1938, one female (L. I. Davis). Nuevo León: Linares, July 8,

1941, three males, two females (L. I. Davis). San Luis Potosí: 24 miles south of Valles, April 12, 1941, two females (A. M. Davis). Morelos: Cuernavaca, October 5, 1940, one male (J. Honey); Cuernavaca, male type of *mirifica* (H. H. Smith, Godman and Salvin collection). Guatemala: Gualan, January 5, 1905, one male.

GENUS LINYPHIA LATREILLE

Linyphia LATREILLE, 1804, *Nouv. Dict. d'Hist. Nat.*, vol. 24, p. 134. (Type, *Araneus triangularis* Clerck.)

Linyphia limbata F. Cambridge

Neriene limbata F. CAMBRIDGE, 1902, *Biologia Centrali-Americana*, Arachnida, vol. 2, p. 420, pl. 39, fig. 23.

RECORDS: Morelos: 7 miles north of Cuernavaca, July 3, 1941, one female (A. M. and L. I. Davis). Vera Cruz: Jalapa, to 10 miles west, June 23, 1936, one female (L. I. Davis).

Linyphia duplicata Cambridge

Neriene duplicata F. CAMBRIDGE, 1902, *Biologia Centrali-Americana*, Arachnida, vol. 2, p. 418, pl. 39, fig. 11.

RECORDS: Mexico: Mountain Pass east of Mexico City, June 20, 1936, eight females (A. M. and L. I. Davis); San Rafael, 2700 to 3000 meters, February 1, 1942, two females (C. Bolívar). Puebla: Riofrio, 3000 meters, April 26, 1942, two males (C. Bolívar, B. Osorio, D. Peláez). Distrito Federal: National Park, near Las Cruces, June 11, 1941, one female (A. M. and L. I. Davis).

The females assigned to the present species, which was based solely on the male, are very closely allied to *limbata* F. Cambridge. However, they are somewhat larger in size, are seemingly more slender, and have the inverted, T-shaped septum of the epigynum proportionately longer. It should be noted, however, that in none of the records are males and females associated in the same collection. There is also considerable variation in the epigynum.

Linyphia nigrita F. Cambridge

Neriene nigrita F. CAMBRIDGE, 1902, *Biologia Centrali-Americana*, Arachnida, vol. 2, p. 419, pl. 39, figs. 19, 19a.

RECORD: Hidalgo: Jacala, June 13, 1936 one female probably this species (A. M. and L. I. Davis).

***Linyphia chiapasica*, new species**

Figure 14

FEMALE: Total length, 2.75 mm. Carapace, 1.07 mm. long, 0.80 mm. wide. Abdomen, 1.70 mm. long, 1.15 mm. wide.

Carapace bright yellow, the pars cephalica with a dusky marginal band and faint dusky radiating lines. The eye tubercles black. Chelicerae and maxillae bright yellow. Sternum and labium dusky brown. Legs dusky yellowish brown. Abdomen mostly white above, with a pair of small black spots on each side at front of caudal half, and a large black spot at apex above the spinnerets. Venter white but with a dusky band from epigynum nearly to apex. Sides white but with a black spot at the base and a wide black band which continues back and joins the black spot visible from above.

Carapace longer than broad, broadly rounded in front, the eye group occupying nearly the full width of the head. First row of eyes essentially straight as seen from in front, the median separated by scarcely the radius, their diameter from the larger lateral eyes. Second row of eyes moderately recurved, the large median on conspicuous black tubercles, separated by about their diameter, very near the smaller lateral eyes which are only two-thirds the diameter of the median. Median ocular quadrangle broader than long (32/26), narrowed in front (32/16), the front eyes very much smaller, about half the diameter of the posterior median eyes. Clypeus equal in height to about two diameters of an anterior median eye. Chelicerae normal, the upper margin with five teeth, of which the median three are considerably larger, the lower margin with five subequal, small teeth. Sternum, 0.60 mm. long, 0.54 mm. wide.

Legs of normal length for the genus, armed with fine hairs and a few weak spines, the first tibia with two pairs of ventral spines. First leg: femur, 1.65 mm.; patella, 0.35 mm.; tibia, 1.55 mm.; metatarsus, 1.58 mm.; tarsus, 0.97 mm.

Abdomen suboval as seen from above, produced slightly forward over the pedicel, in front about as high as broad, rounded at distal end without conspicuous anal tubercle. Epigynum as illustrated in figure 14.

TYPE LOCALITY: Female holotype from Catharinas, Chiapas, Mexico, 1400 meters, May 4-22, 1942 (H. Wagner).

This pretty species is easily separated from known forms by the bright color pattern and especially by the epigynum which is illustrated. The median septum is a very narrow, linear ridge.

***Linyphia xilitla*, new species**

Figure 13

FEMALE: Total length, 3.70 mm. Carapace, 1.30 mm. long, 0.80 mm. wide. Abdomen, 2.50 mm. long, 1.30 mm. wide.

Carapace dark brown with darker radiating streaks on the pars thoracica, the eye tubercles black. Sternum and mouth parts dark brown. Legs dusky yellowish brown. Abdomen black, except for a few small paler flecks on the dorsum and four larger white spots on each side.

Structure essentially as in *chiapasica*. First row of eyes essentially straight as seen from in front, the median separated by their radius, a full diameter from the larger lateral eyes. Second row of eyes moderately recurved, the large median eyes or conspicuous tubercles on a median elevation, separated by their diameter, only a fourth as far from the smaller lateral eyes. Median ocular quadrangle broader than long (30/26), narrowed in front (30/20), the front eyes very much smaller. Clypeus equal in height to two and one-half diameters of an anterior median eye. Chelicera normal, the upper margin with five large unequal teeth, the lower with five smaller ones. Sternum, 0.80 mm. long, 0.56 mm. wide.

Legs weakly spined, the first tibia with two ventral pairs but without apical spines. First leg: femur, 1.85 mm.; patella, 0.45 mm.; tibia, 1.60 mm.; metatarsus, 1.75 mm.; tarsus, 0.95 mm. Tibia and patella of the fourth leg, 1.65 mm. long.

Abdomen as seen from above, a long oval, rather pointed behind, nearly as high as long, distally produced above the spinner-

ets into a pointed tubercle. Epigynum as illustrated in figure 13.

TYPE LOCALITY: Female holotype from Cordoba, Vera Cruz, Mexico (A. Petrunkevitch).

RECORDS: San Luis Potosi: Xilitla, December 2, 1939, female paratype (A. M. and L. I. Davis); Tamazunchale, July 10, 1939, female paratype (A. M. and L. I. Davis).

This pretty species seems to be closely allied to *palida* Cambridge described from Guatemala, if one may judge from the similarity of the epigynum. However, the great differences in coloration and pattern would seem to preclude the possibility that the strongly marked Mexican specimens are the same.

SELENYPHANTES, NEW GENUS

A genus of the subfamily Linyphiinae. Carapace much longer than broad (100/72), broadly rounded in front, the head at the second eye row three-fifths as wide as the carapace. Clypeus sloping forward, equal in height to two diameters of an anterior median eye. First row of eyes straight as seen from in front, the median separated by about their radius, two full diameters from the slightly larger lateral eyes. Second eye row gently recurved, the median separated by slightly more than the diameter, a little farther from the subequal lateral eyes. Lateral eyes of each side subequal, contiguous on a low, connate tubercle. Median ocular quadrangle slightly longer than broad, much narrower in front, the posterior eyes larger. Pedipalp of female with claw. Legs long and slender, the first femur twice as long as the carapace, the fourth tibia with two dorsal spines. Embolus of male palpus a long, fine spine.

GENOTYPE: *Leptyphantes longispinosa* O. P.-Cambridge.

Selenyphantes is related to *Linyphia*, *Helophora*, and allied genera, but differs in having longer legs, in the details of the eye relations, and especially in the genitalia. The epigynum of the female lacks a prominent scape. The male palpus is very similar to that of *Jalapyphantes cuernavaca*, a

species which is otherwise very different in appearance.

Selenyphantes longispinosa

O. P.-Cambridge

Figure 12

Leptyphantes longispinosa O. P.-CAMBRIDGE, 1902, *Biologia Centrali-Americana*, Arachnida, vol. 1, p. 188, pl. 23, figs. 8-8f.

RECORD: Vera Cruz: Jalapa to 10 miles west, June 23, 1936, male and two females (A. M. and L. I. Davis).

The female of this species is very similar in appearance to the male but has the unmarked, pale abdomen proportionately stouter. The epigynum (fig. 12) is on a moderately elevated prominence and shows a broad median piece which is shallowly excavated on each side in front.

JALAPYPHANTES, NEW GENUS

A genus of the subfamily Linyphiinae. Carapace somewhat longer than broad, broadly rounded in front, the pars cephalica quite broad, equal in the female to about three-fifths the greatest width of the carapace. Clypeus sloping gently forward, equal in height to about three diameters of an anterior median eye. Maxillae longer than wide. Eyes of first row straight, subequidistantly spaced, the median smaller. Lateral eyes subequal, contiguous on connate tubercles. Posterior eye row gently recurved, subequally spaced and subequal in size. Median ocular quadrangle as long as or slightly longer than broad. Upper margin of the chelicera with three large teeth, the lower margin with six small teeth. Pedipalp of female with claw. Legs quite stout, rather sparsely set with spines, many of which are lateral in position. Fourth tibia with two dorsal spines. Abdomen subglobose, elevated in front. Embolus of male palpus a long fine spine.

GENOTYPE: *Jalapyphantes cuernavaca*, new species.

The members of this genus resemble in a general way the species of *Labulla*, *Pimosa*, and *Tapinopa*, but they are considerably smaller in size. The differences in the eye relations will serve to distinguish them. The epigyna of the three known species of *Jalapyphantes* are very similar and present

two prominent, sclerotized elevations between which lies a narrow finger or scape.

***Jalapyphantes puebla*, new species**

Figure 16

FEMALE: Total length, 3.70 mm. Carapace, 1.50 mm. long, 1.30 mm. wide. Abdomen, 2.40 mm. long, 1.80 mm. wide.

Carapace light yellowish brown, the sides of the pars cephalica with a dark brown marginal band, the midline with a dark brown band as wide as the eye group and which is slightly narrowed as it goes back to the caudal margin. Clypeus with a dusky spot immediately below the eyes, otherwise pale. Chelicerae yellowish brown, somewhat dusky in front. Sternum yellowish brown, rather broadly margined with black. Labium black except for white tip; maxillae dusky yellowish brown. Legs yellowish brown, dusky, the femora, tibiae, and metatarsi with median and apical black rings, the tarsi only with a median dark ring. Palpus also ringed with black. Abdomen mostly gray above, with an indistinct pattern of darker chevrons on the distal half and presenting numerous small white flecks; sides mottled with black; the venter with a paler area enclosing small white spots.

Carapace longer than broad, the pars cephalica broadly rounded in front, the head at the second eye row equal to three-fifths the greatest width of the carapace. Pars cephalica as seen in side view highest at the second eye row, the eye group projecting somewhat over the gently sloping clypeus. Eye group five-sevenths the width of the head at the second row, the eyes closely set. First row of eyes as seen from in front straight, as seen from above strongly recurved, the median nearly contiguous at the base, separated from the larger laterals by their radius. Lateral eyes of each side subequal, contiguous on connate tubercles. Posterior eye row gently recurved, a line along the upper edges of the lateral cutting through about one-fifth of the medians, the median separated by their radius, only slightly more distant from the equal lateral eyes. Median ocular quadrangle longer than broad (32/29), the front eyes much smaller in the

ratio of 10:14. Clypeus equal in height to three diameters of an anterior median eye. Chelicera with a few long hairs on the frontal surface, the upper margin with three long pointed teeth and a weak denticle at side of one nearest the base of claw, the lower margin with six small teeth. Sternum, 0.80 mm. long, 0.80 mm. wide.

Legs moderately stout, armed with weak spines. First leg: femur, 1.90 mm.; patella, 0.55 mm.; tibia, 1.80 mm.; metatarsus, 1.73 mm.; tarsus, 1.14 mm. Tibia and patella of the fourth leg, 1.80 mm.

Abdomen suboval as seen from above, elevated in front, broadly rounded and declining behind, oval as seen from the side. Epigynum as illustrated in figure 16.

TYPE LOCALITY: Female holotype from Riofrio, Puebla, Mexico, 3000 meters, April 26, 1942 (C. Bolivar, B. Osorio, D. Peláez).

RECORDS: Distrito Federal: Desierto de los Leones, March 22, 1941, female and immature male paratypes (M. Correa, M. Cardenas).

***Jalapyphantes minorata*, new species**

Figure 15

FEMALE: Total length, 2.00 mm. Carapace, 0.92 mm. long, 0.74 mm. wide. Abdomen, 1.15 mm. long, 1.05 mm. wide.

Coloration in rather close agreement with *puebla*. Brown median stripe of carapace as wide as the eyes in front, gradually narrowed and ended behind the end of the inconspicuous median groove. Brown bands of the pars thoracica much broader than in *puebla*, leaving only a narrow V-shaped paler maculation on the carapace. Clypeus dusky. Sternum light brown, rather narrowly ringed with black. Legs strongly ringed with black, essentially as in *puebla*, but the rings more extensive. Abdomen dusky, the dorsum with a series of creamy white, irregular spots in the middle; sides black with small creamy white flecks and spots; the venter with the broad paler stripe flanked by large creamy white maculations.

Structure essentially as in *puebla*. Eyes proportionately a little larger and closer together. First row of eyes as seen from in front gently recurved but essentially

straight, the median scarcely separated at their base and as far from the larger lateral eyes. Eyes of the posterior row gently recurved, the median separated by one-third the diameter, as far from the equal lateral eyes. Median ocular quadrangle as broad as long, narrowed in front (31/24). Clypeus equal in height to two diameters of an anterior median eye. Chelicerae armed as in *puebla*.

Legs of moderate stoutness with a few weak spines, and seemingly without paired ventral spines. First leg: femur, 1.00 mm.; patella, 0.30 mm.; tibia, 0.90 mm.; metatarsus, 0.93 mm.; tarsus, 0.63 mm. Tibia and patella of the fourth leg, 1.00 mm. long. Epigynum as illustrated in figure 15.

TYPE LOCALITY: Female holotype from Mountain Pass east of Mexico City in the state of Mexico, June 20, 1936 (A. M. and L. I. Davis).

Jalapyphantes cuernavaca, new species

Figures 17 and 18

FEMALE: Total length, 3.20 mm. Carapace, 1.10 mm. long, 0.90 mm. wide. Abdomen, 2.10 mm. long, 1.70 mm. wide.

Coloration essentially as in the previously described species except as follows: carapace dusky brown with a few darker radiating lines but without lighter markings or pattern. Legs very broadly ringed with black.

Structure essentially as in the other species. First row of eyes straight as seen from in front, the median separated by a third the diameter, about the same distance from the larger lateral eyes. Posterior eye row gently recurved, the median separated by scarcely their radius, a radius from the equal lateral eyes. Median ocular quadrangle as broad as long, narrowed in front (34/27), the front eyes smaller. Clypeus equal in height to three diameters of an anterior median eye. Sternum, 0.66 mm. long, 0.64 mm. wide. Chelicera with three large teeth on the upper margin and six small ones on the lower.

Legs clothed with fine hairs and a few dorsal, lateral, and ventral spines on the femora and tibia. First leg: femur, 1.35

mm.; patella, 0.40 mm.; tibia, 1.25 mm.; metatarsus, 0.27 mm.; tarsus, 0.78 mm. Tibia and patella of the fourth leg, 1.30 mm.

Epigynum as illustrated in figure 18.

MALE: Total length, 2.70 mm. Carapace, 1.33 mm. long, 1.14 mm. wide. Abdomen, 1.50 mm. long, 1.10 mm. wide.

Coloration in rather close agreement with the female. Carapace all dark brown but marked with radiating black streaks. Sternum light brown, irregularly margined with black. Legs ringed in black. Abdomen essentially as in the female.

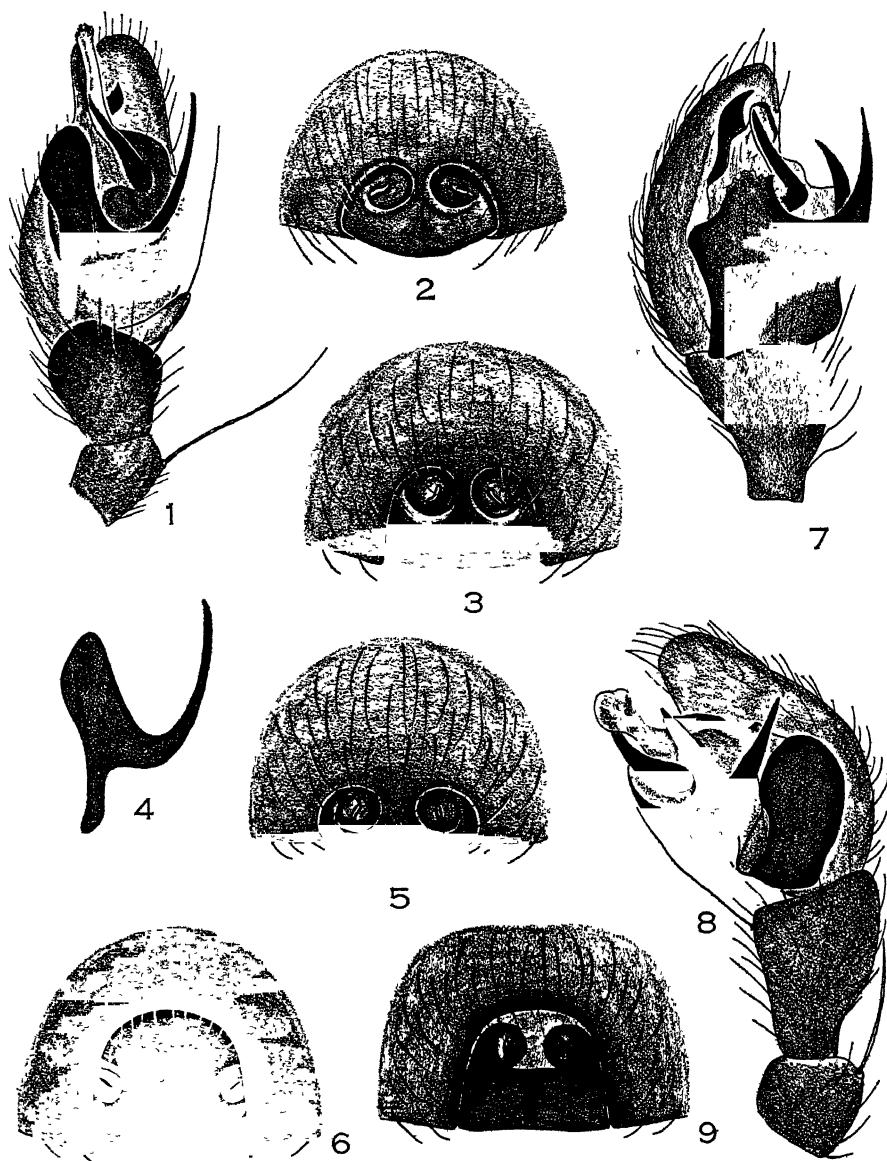
Structure essentially as in the female. Carapace a little longer than broad, broadly rounded behind and on the sides, only slightly narrowed in front. Eye group set on a lobe which projects over the gently sloping clypeus. Eye relations essentially as in the female. First row of eyes straight, median separated by less than a radius, about twice as far from the lateral. Posterior eye row gently recurved, the median separated by a radius two-thirds their diameter from the equal lateral eyes. Median ocular quadrangle as broad as long, narrowed in front (34/24), the front eyes smaller. Clypeus equal in height to four diameters of an anterior median eye. Chelicera essentially as in the female but the upper margin with two large teeth toward the end of the claw and a smaller tooth near the base of the claw, leaving a space between equal to the width of the two larger teeth. Lower margin with five small teeth. Sternum, 0.70 mm. long, 0.75 mm. wide.

Legs proportionately longer than in the female, the spines seemingly the same. First leg: femur, 1.50 mm.; patella, 0.40 mm.; tibia, 1.47 mm.; metatarsus, 1.47 mm.; tarsus, 0.90 mm. Tibia and patella of the fourth leg, 1.40 mm.

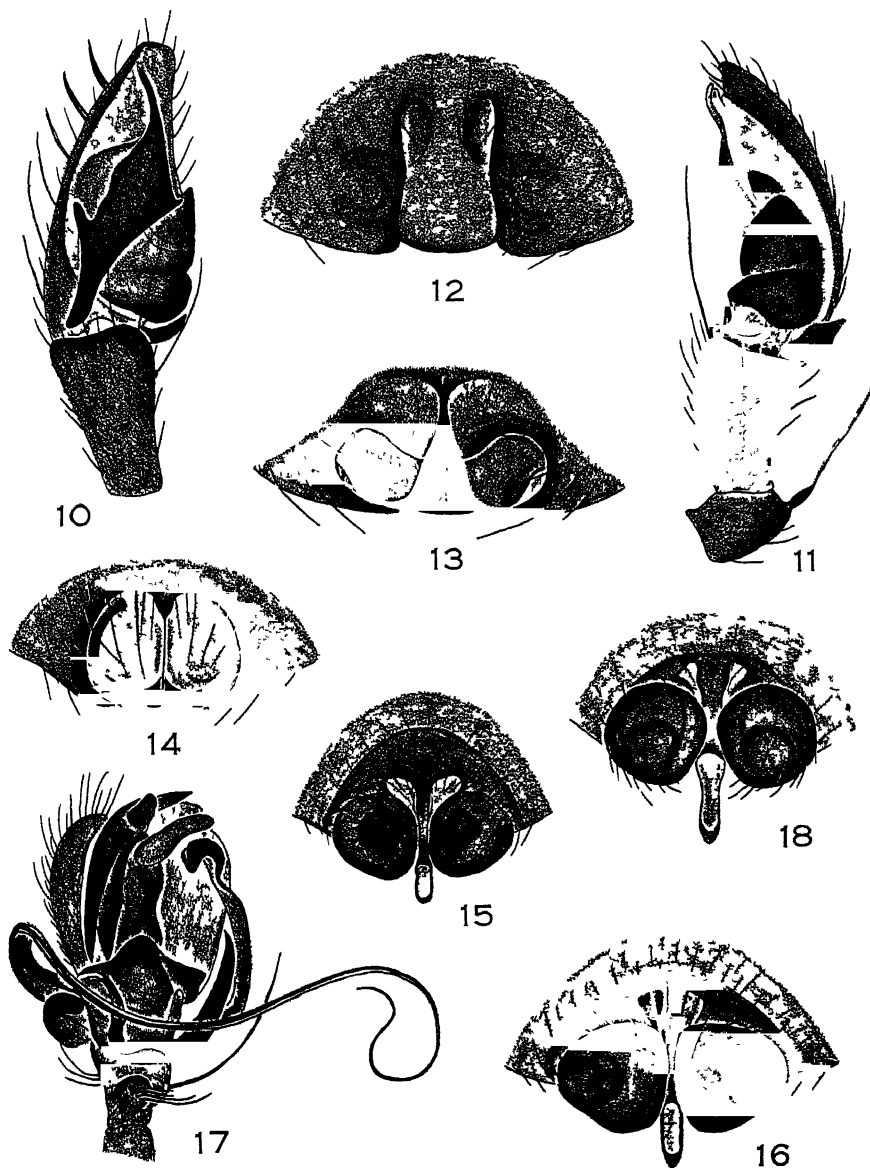
Palpus as illustrated in figure 17.

TYPE LOCALITY: Male holotype from Horsetail Falls, Nuevo Leon, June 11, 1936 (A. M. and L. I. Davis).

RECORDS: Morelos: 7 miles north of Cuernavaca, July 3, 1941, female allotype and two female paratypes (A. M. and L. I. Davis).



- Fig. 1. *Frontinella huachuca benevola*, new subspecies, left male palpus, ventral view.
 Fig. 2. Idem, epigynum, ventral view.
 Fig. 3. Idem, epigynum, caudal view.
 Fig. 4. *Frontinella huachuca*, new species, lamella of left male palpus, ventral view.
 Fig. 5. Idem, epigynum, ventral view.
 Fig. 6. *Frontinella caudata*, new species, epigynum, ventral view.
 Fig. 7. *Frontinella potosi*, new species, left male palpus, subventral view.
 Fig. 8. Idem, left male palpus, retrolateral view.
 Fig. 9. Idem, epigynum, ventral view.



- Fig 10 *Frontinella lepidula*, new species, left male palpus, subventral view
 Fig 11. Idem, left male palpus, retrolateral view
 Fig 12 *Selenyphantes longispinosa* O P-Cambridge, epigynum, ventral view.
 Fig 13 *Linyphra xilitla*, new species, epigynum, ventral view
 Fig 14 *Linyphra chiapasra*, new species, epigynum, ventral view
 Fig 15 *Jalapyphantes minorata*, new species, epigynum ventral view
 Fig 16 *Jalapyphantes puebla*, new species, epigynum ventral view
 Fig 17 *Jalapyphantes cuernavaca*, new species, left male palpus, ventral view
 Fig 18 Idem, epigynum, ventral view.

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NOTES ON *STROMBUS DENTATUS* LINNE AND THE *STROMBUS URCEUS* COMPLEX

BY HENRY DODGE

A remark made by Tryon in his monograph on the Strombidae (1885, p. 118) in discussing *Strombus dentatus* Linné has prompted me to examine the taxonomic history of the species in the so-called *dentatus* group. Tryon there said: "The difference between this species and *S. urceus* is so slight, and there is so much variation in the shells, that it is very doubtful whether their separation can be maintained."

A reading of the meager references to this group, a study of the synonyms involved, and an examination of a considerable series of specimens disclose an obvious confusion which appeared as early as Gmelin and has persisted in the minds of all but a few authors since his day. I have concluded that:

1. *Dentatus* Linné is not identical with *urceus* Linné or with any form of the *urceus* of authors, and Tryon's remark is true only if we assume that he was speaking of the shells which are today almost universally known as *dentatus* and *urceus* Linné in our collections. It is not true if he meant the *dentatus* and *urceus* described by Linnaeus.

2. *Dentatus* as described in the "Systema naturae" is identical with the shell described by Gmelin in 1791 and Lamarck in 1822 as *tridentatus*, by Chemnitz in 1777 as *dentatus*, and by Reeve in 1851 as *samarensis*. The other names mentioned should therefore be thrown into the synonymy of *dentatus* Linné and that shell disassociated from any form of *urceus* Linné.

3. *Urceus* Linné is tentatively to be listed as unidentifiable. The various forms of the complex known as the *urceus* of authors seem to be one species for which the earliest valid name is *Strombus ustu-*

latus Schumacher, 1817. This complex presents such extremes of form, however, that further study may justify its separation into subspecies or even species.

1

On the first point we should turn immediately to the Linnaean descriptions:

Strombus urceus LINNAEUS, 1758, p. 745, No. 440; 1767, p. 1212, No. 512.

"S. testae [sic] labro attenuato retuso brevi striato, ventre spiraque plicato-nodoso, apertura bilabiata inermi."

TRANSLATION: Shells with a "thinned-out," reflected, short, and ridged lip, body-whorl and spire plicate-nodose, aperture bilabiate and lacking armature.

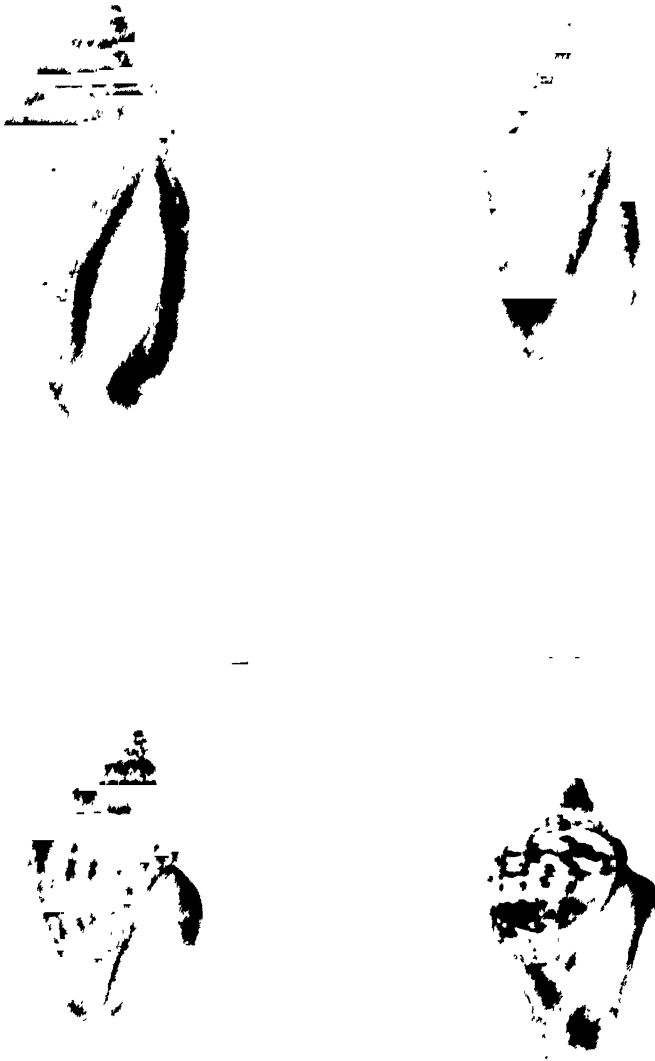
Strombus dentatus LINNAEUS, 1758, p. 745, No. "o"; 1767, p. 1213, No. 513.

"S. testa labro attenuato brevi dentato, ventre spiraque plicatis."

TRANSLATION: Shell with a "thinned-out," short and toothed lip, body-whorl and spire plicate.

The figures shown in the synonymy of Linné's *urceus* all show approximations to the more or less strongly plicated form of the *urceus* of authors, although it is to be noted that this is not the form usually labeled *urceus* in our collections, which is in most cases the larger, more graceful, and less plicate shell. It is unfortunate that Linnaeus did not supply a synonymy for *dentatus* in either the tenth or twelfth edition of the "Systema." Had he done so the question of its identity might never have arisen.

It is obvious that the confusion in the identity of *dentatus* and its fancied relation to *urceus* have arisen from a careless reading of the Latin description. But the conclusion seems inescapable that Linnaeus was describing two entirely different shells. The reflection of the lip and the presence of nodes in *urceus* are not indicated in the



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Fig. 1. *Strombus ustulatus* Schumacher, form *laevis*, new name. (*S. urceus* of most authors, *non* Linné.) No locality data. A.M.N.H. No. 12927.

Fig. 2. *Strombus dentatus* Linné (*S. tridentatus* Gmelin). Philippine Islands.

Fig. 3. *Strombus ustulatus* Schumacher, form *plicatus*, new combination. (*S. dentatus* of most authors, *non* Linné.) Catanduanes, Philippine Islands.

Fig. 4. *Strombus floridus* Lamarck (*S. mutabilis* Swainson). "Indian Ocean." A.M.N.H. No. 49418.

Figures 1 and 3 are examples of the extreme forms of *S. ustulatus* from the standpoint of sculpture. All figures $\times 1$. Photographs by Marion A. Bills.



Back views of shells illustrated in figures 1 to 4.

Fig. 5. *Strombus ustulatus* Schumacher, form *laevis*.

Fig. 6. *Strombus dentatus* Linné.

Fig. 7. *Strombus ustulatus* Schumacher, form *plicatus*.

Fig. 8. *Strombus floridus* Lamarck.

All figures $\times 1$. Photographs by Marion A. Bills.

description of *dentatus*. The aperture of *urceus* is stated to be "inermi," whereas the lip of *dentatus* is "dentato." In the latter species he was describing a shell with a toothed lip. Linnaeus' language can be read in no other way. It is true that in certain other descriptions Linnaeus dignified the striae or furrows of the inner aspect of the lip (which are present in all shells of the group here discussed) with some name derived from the Latin "dens." I have, however, examined the descriptions of every other species of gastropod for which he used "labro dentato" or words of like import, and can report that in no case did he employ such an expression for a shell which did not have true teeth on the edge of the lip or on its inner aspect. As an illustration, compare *Voluta mercatoria* (1758, No. 357)—our *Pyrene mercatoria*—"labroque introrsum gibbo denticulato"—with *Murex fusus* (1758, No. 478)—our *Tibia fusus*—"labro dentato". In the first case the "teeth" are mere ridges inside

the lip. In the latter they are true teeth on the lip.

There may have been a difference of opinion as to whether the word "brevi" in the description of both *urceus* and *dentatus* is an adjective modifying "labro" or an adverb modifying "dentato." I suggest that a study of the descriptions on page 745 of the tenth edition of the "Systema," which contains two broad-lipped species, *gigas* and *latissimus*, and the several short-lipped species, *epidromis*, *canarium*, *vittatus*, *urceus*, and *dentatus*, should satisfy one that "brevi" is an adjective modifying "labro." It must be admitted that Linnaeus used "brevi" very broadly as applied to the lips of the species mentioned. It is true that they are all short-lipped, but the shortness varies in degree. The true *dentatus* Linné (*tridentatus* Gmelin) has an unusually abbreviated lip, and Linnaeus might well have indicated this by more emphatic phraseology.

Thus *dentatus* possesses a characteristic

which is not present in any of the forms of the *urceus* complex, unless one is willing to use the word "teeth" for the irregularities or crenulations produced by the stromboid notch. These irregularities, which are well shown in the figure from Chenu and Reeve reproduced by Tryon in volume 7 of the "Manual of conchology," are often pronounced, but in no case are there more than two, and these are short, blunt, and rounded and are mere modifications of the crenulations present in most forms of the *urceus* complex. If these features may be called "teeth," then virtually every *Strombus* would have to be described as "dentato."

I have examined a considerable series of specimens labeled *urceus* Linné, *dentatus* Linné, and other names which will be mentioned later, in several private collections and in the collections of two large museums, and in every case those identified as *dentatus* were, within the limits of the variations present in this complex, very close to those identified as *urceus*. I am therefore forced to the conclusion that both the *dentatus* and the *urceus* of authors and of our collections are very closely allied if not conspecific.

The noticeably variable traits are: the length, prominence, and spacing of the axial plications on the body whorl; the degree to which the stromboid notch is developed; the degree and form of the thickening of the lip; the sculpture of the spire and the color pattern. The most important color variation is the presence of a black or purplish black columella or outer lip or both. This color is so striking that many of the early conchologists mention it in describing *urceus*, thus making it a definite characteristic of the species. (Cf. Lamarck, 1822, "labrum caudaque nigricante . . . fauce nigra"; Chemnitz, 1845 edition, where the shell is called "Die Schwartzmündige Flügelschnecke"; Knorr, 1768, who calls it "Die Schwartzmündchen"; and Reeve, 1851, who says, vol. 6, pl. 11, "This species may generally be recognized by the dark purple-black coloring of the columella and aperture, which in some specimens is, however, only partially indicated.") The fact is that the great

majority of specimens labeled *urceus* have a colorless or yellow-orange columella and lip. The black is the exception. The black individuals were mostly of the smoother form in the series examined, although the plicated form showed a few black specimens.

In all these variations I failed to find, between lots of individuals possessing a given group of traits and other lots possessing other groups of traits, any real points of cleavage sufficiently marked to justify the conviction that any form is entitled to specific or subspecific rank. The variations, although presenting very wide extremes, are nevertheless connected by such a complete chain of intermediates that I cannot find any evidence of discontinuity at any point. Nor have I been able to formulate any conclusion as to geographical races upon the stated locality of the series examined. The most extreme forms are found over the entire range of the shells involved, which extended from Mindoro in the Philippines to Australia, the New Hebrides, and the Paumotu, and as far west as the Red Sea and Mauritius. Nor were any of the lots examined sufficiently documented to enable one to determine whether temperature or salinity of water, type of bottom, nature of food, or any other ecological factors could be given any weight. There is, perhaps, room for further useful study along this road.

2

If *dentatus* Linné was not the *dentatus* of our museums, what was it?

Chemnitz (1788, vol. 10, pp. 220-221), in describing *dentatus*, correctly read the Linnaean description calling it "Die Gezähnte Flügelschnecke" and specifically describing its lip as "labro infra dentato." He cited figures from Seba showing a shell with a definitely toothed lip as distinct from a crenulated lip or one with "teeth" consisting of the sides of the stromboid notch. The figures shown in the volume of plates appended to volume 10 of the "Conchylien Cabinet" are the most accurate pictures of the tridentate *Strombus* that have appeared in any iconography with the exception of that of Reeve.

Chemnitz, however, complicated the issue by describing another shell, *S. samar*, new name (1788, vol. 10, p. 221). While *samar* was not described as having a dentate lip, its pictorial synonymy showed a figure which probably represents a young *tridentatus* Gmelin with very rudimentary teeth. Yet the name is in use today, and many specimens of typical *tridentatus* labeled *samar* Chemnitz are found in our collections. I have no idea what Chemnitz was describing in his *samar*. Either the name must be rejected as unrecognizable or be made a synonym of *dentatus* Linné according to the amount of clairvoyance we can exert in reading Chemnitz' description. Sowerby's *Strombus bullatus* has been suggested as being equal to *samar*, but the vagueness both of Chemnitz' figure and of Sowerby's figures of *bullatus* precludes any certain identification.

The mistake which has plagued *dentatus* Linné began with Gmelin. In the thirteenth edition of the "Systema naturae" he listed two shells described as having dentate lips although only one is known: *S. dentatus* and *S. tridentatus* (1791, p. 3519, Nos. 31 and 30, respectively). The description of the first is copied bodily from Linnaeus with a long sub-description which adds nothing in regard to the lip. The description of the second is a good diagnosis of the tridentate *Strombus*, the words "labro triacantho" being much more graphic than the language used by Linnaeus. It is impossible to guess what shell Gmelin thought he was presenting in his *dentatus*. The figures he cited for it are varied. Some clearly show *tridentatus*, and others picture one or another of the forms of the *urceus* of authors. Whether his *lapsus* means that he thought that his *tridentatus* was hitherto undescribed or whether he meant to change the Linnaean specific name to his own and then restore it for a form of *urceus* is only a matter of conjecture.

Lamarck was also in error in his conception of *dentatus* Linné. He describes *tridentatus* (1822, vol. 7, p. 209) very graphically, using the words "basi tridentato," and supplies a partially correct synonymy. He also lists *S. plicatus*, new

name (*op. cit.*, p. 210) of which he says in his French description, "its right border is not dentate but shows at its lower end the characteristic sinus of the genus." He follows this by citing *S. dentatus* Linné as a synonym, thus becoming the first author definitely to identify *dentatus* Linné with a member of the *urceus* complex (*urceus* of authors).

It is not possible within the limits of this paper to discuss the opinion of all the authors who have listed this species. Suffice it to say that Chemnitz and his revisers in the 1845 edition, Sowerby (1847, *Strombus*, p. 31), and Hanley (1855, p. 276) either directly or indirectly properly identified *dentatus* Linné with *tridentatus* Gmelin, thus correctly interpreting the Linnaean description. All the others, notably Gmelin, Lamarck and his revisers, Deshayes and Milne Edwards (1845, vol. 9, p. 706), Reeve (1851, vol. 6, pl. 9, fig. 17), and Tryon (1885, vol. 7, p. 118) have continued the old error of identifying it with some form of the *urceus* of authors.

Hanley was the last writer who properly read the Linnaean description. Since his day I can find no mention or figure of *dentatus* which suggests that it is anything else than a form of the *urceus* of authors of the more plicate type, and the labels in our collections follow this lead. If we base our opinion upon the number of supporters of each theory certainly the evidence is preponderantly in favor of the view presented in this paper. And if we study the figures cited by all the authors through Hanley, and particularly if we go to the final and best source—Linnaeus' own language—we are forced to the conclusion that the *dentatus* in our museums is not the *dentatus* of Linnaeus. The very name given to the latter was a description of it, and, incidentally, it is the only gastropod to which he gave this name. That fact is surely additional evidence.

3

I have already said that I cannot separate out any species or subspecies from among the very variable group called the "*urceus* of authors," in which I include the *dentatus*

of most authors. The larger question is: Just what shell was Linnaeus describing in *urceus*? The following notes suggest that the *urceus* of all authors following Linnaeus was a different shell from that described by him, and that the identity of his *urceus* has not been satisfactorily determined.

For almost a century after Linnaeus I can find no comments in the literature suggesting that the *urceus* of all authors had not been described in the "Systema." The first who raised the question was Hanley. On page 275 of his "Ipsa Linnaei conchylii" (1855) he says: "One regrets to disturb a long established identification, yet truth compels me to declare that the *S. urceus* of modern writers is not the true representative of the species thus named by our author. We shall not find among the synonyms a single characteristic drawing of that shell . . . On the contrary it is the *S. mutabilis* (Seba Mus. vol. iii, pl. 60, f. 28 etc.) and the *S. plicatus* (Rumph. pl. 37, f. T. etc.), the former of which is marked for this species in the Linnaean cabinet, where the supposititious *urceus* is not present, to which our attention is directed by the references."

As I am treating *S. plicatus* Lamarck as one of the forms of the *urceus* of authors, and as it will be shown that Hanley was in error as to the identity of *mutabilis* Swainson with *urceus* Linné, the only helpful part of his comment is his conviction that the post-Linnaean authors were not describing Linnaeus' *urceus*. One reason given by him for this opinion was that "the striking color of the aperture in *urceus* was not mentioned in the description" (*loc. cit.*). This undoubtedly refers to the black lip and columella already discussed. Thus my strong impression is that Hanley meant, by the expression "the *urceus* of authors," the black-lipped form. The two most recent iconographies of the Strombidae in Hanley's day were the second edition of the "Conchylien Cabinet" (1845, vol. 4) and Reeve's "Conchologia iconica" (1851, vol. 6), both of which mention the black aperture as a specific determinant of *urceus* Linné. Likewise the best of Sowerby's figures in the "Thesaurus conchiliorum" shows this form. It seems reason-

able to suppose that Hanley utilized these works.

Watson (1886, p. 417) followed Hanley in holding that the *urceus* of authors was not the *urceus* of Linnaeus and also perpetuated what I feel was Hanley's error in believing that *S. floridus* Lamarck (*S. mutabilis* Swainson) was the Linnaean type. In looking for a valid name for the *urceus* of authors he chooses the earliest post-Linnaean name, *Canarium muricatum* Martini, 1777, adding that after Martini the next in line of priority would be *Strombus ustulatus* (*Canarium ustulatum*) Schumacher, 1817. As the Martini names have been officially rejected as not being consistently binomial, the first valid name is that of Schumacher. As will appear, I disagree with Watson's identification of *S. urceus* Linné with *S. floridus* Lamarck.

Tryon's description of *urceus* Linné (*op. cit.*, p. 118) recalls the smooth form of the *urceus* of authors for which I propose the name: form *laevis*. As to the color of the aperture he says (*loc. cit.*), "lip, aperture and columella deep orange-brown, or chestnut, or more usually deep chocolate or black," showing that he was impressed by the "Schwartzmündige" form as being rather typical than otherwise. He makes the species synonymous with *S. ustulatus* Schumacher, 1817, *S. incisus* Wood, 1828, and *S. anatellus* Duclos (*in* Chenu), 1844. His figures (pl. 6, figs. 65-67) show two smooth forms and one apparently with no plications but with strong nodes at the shoulder; two with a strongly plicated spire and one with the spire virtually smooth. Tryon makes no suggestion that there is any difference between the *urceus* of authors and the species that Linnaeus described.

C. Hedley (1904, p. 188) also appears to agree with Hanley that *urceus* Linné was *S. floridus* Lamarck (*S. mutabilis* Swainson) and adds (*loc. cit.*) "the *urceus* of authors is *S. ustulatus* Schumacher 1817."

W. Adam and E. Leloup (1938, pp. 112-116) believed that the *urceus* of authors was identical with *S. plicatus* Lamarck for which they gave an exhaustive synonymy including *S. dentatus* Gmelin, 1791. They were unwilling, however, to pass definitely

upon the identity of Linnaeus' *urceus*, but do disagree with Hanley, Watson, and Hedley, saying (*op. cit.*, p. 115): "As to the interpretation of *Strombus urceus* Linné we do not agree that it is identical with *S. floridus* Lamarck" (translation).

This is the state in which the problem of the identity of *urceus* Linné is left today. Hanley, Watson, and Hedley believe that he was describing *S. floridus* Lamarck. Certainly if that shell is present in the Linnaean cabinet, as Hanley reported, and marked for *urceus*, that fact is weighty but not conclusive evidence. In any event it would be useful to check Hanley's statement by an examination of the collection *de novo* as soon as that becomes possible. Linnaeus' description of *urceus*, however, omits many of the most characteristic features of *floridus*. Hanley uses Linnaeus' omission of any reference to "the striking color of the aperture" as evidence that he was not describing the *urceus* of authors. Might it not also be said that the omission of a reference to the rosy pink color of the aperture of *floridus* was evidence that he was not describing that shell? In fact the description of *urceus*, although broad enough to cover many forms in this general group, is woefully inapplicable to *floridus*, and I will always contend that Linnaeus' descriptions, short though they may be, are entitled to more weight than the figures he cites or the presence or absence of marked specimens in his collection. In addition to the failure to mention the pink color of the aperture there is no hint of the characteristic shoulder at the upper end of the lip. There is no mention of the folds across the entire length of the columella. Most significant of all, the words "ventre spiraque plicato-nodosus" in the description of *urceus* are utterly inapt as applied to *floridus*.

In the last analysis the only evidence in favor of *floridus* as the representative of *urceus* Linné is the fact that a specimen of *floridus* was said to have been found in Linnaeus' collection. This may well have been a mistake of Linnaeus himself or of

someone following him to whom the custody of his cabinet was entrusted. A reading of the Introduction to Hanley's work (*supra*) should convince one that not only the vicissitudes which the collection has suffered but Linnaeus' own inaccuracies as well leave much room for charges of error of this sort. I must therefore conclude that *urceus* Linné is not *floridus* Lamarck. It is not the black-lipped form of the *urceus* of authors as that form also has a smooth or almost smooth body-whorl. It may have been a shell something like *plicatus* Lamarck. But on the state of the evidence I am content to consider it among the "lost" species of Linnaeus.

In summary I suggest:

1. That *S. urceus* of authors not Linné, *S. dentatus* of authors not Linné, *S. plicatus* Lamarck, and the other names cited as synonyms of *urceus* and *dentatus* Linné by Tryon are all forms of a variable species which should receive the name *Strombus ustulatus* Schumacher, 1817, at least while awaiting further study. I here propose for the extremely smooth form of *ustulatus* the name "form *laevis*," and for the plicate form, the name "form *plicatus*."

2. That *S. urceus* Linné be rejected as an undetermined species.

3. That *S. tridentatus* Gmelin, 1791, *S. tridentatus* Lamarck, 1822, and *S. samarensis* Reeve, 1851, are all synonyms of a well-defined species with extremely constant characteristics which should retain the first name of *S. dentatus* Linné. It is unfortunate that the well-established name *tridentatus* should have to be abandoned in favor of the less graphically descriptive *dentatus*, particularly in view of the confusion of that name with certain forms of the *urceus* of authors. (It is conceivable that the International Commission on Zoological Nomenclature might hold that Linnaeus' brief and somewhat unenlightening description of *dentatus* and his failure to provide any synonymy or locality would preclude the retention of the Linnaean name, in which case the species would become *S. tridentatus* Gmelin, 1791.)

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A REVIEW OF MIDDLE NORTH AMERICAN TOADS OF THE GENUS *MICROHYLA*

BY MAX K. HECHT AND BESSIE L. MATALAS

As currently understood, three nominal species of the narrow-mouthed toads, *Microhyla*, inhabit the southeastern and central portions of the United States, with ranges extending into Mexico. In "A check list of North American amphibians and reptiles," Stejneger and Barbour (1943) list *Gastrophryne areolata* (Strecker), *Gastrophryne carolinensis* (Holbrook), and *Gastrophryne olivacea* (Hallowell). The purpose of this paper is to ascertain the taxonomic status and ranges of these forms.

We are indebted to Dr. Albert H. Wright of Cornell University for his kind encouragement and stimulating interest in the problem, to Mr. Charles M. Bogert for his criticism and numerous suggestions in

the preparation of this manuscript as well as for aid in obtaining loans of material, and to Mr. Plato Taleporos for the drawings accompanying the text. The authors are also grateful to Dr. Doris M. Cochran, Mrs. Helen T. Gaige, Mr. Karl P. Schmidt, and Dr. Hobart M. Smith for the loan of material.

Approximately 650 narrow-mouthed toads in the collections of the United States National Museum (U.S.N.M.), American Museum of Natural History (A.M.N.H.), Cornell University (C.U.), University of Michigan Museum of Zoology (U.M.M.Z.), Chicago Natural History Museum (C.N.H.M.), and the University of Rochester (U.R.) have been examined.

NOMENCLATORIAL HISTORY

In 1836 Holbrook described *Engystoma carolinensis*, from Charleston, South Carolina. *Engystoma olivaceum* was described by Hallowell from "Kansas and Nebraska" in 1856 and redescribed as a new species, *Engystoma texense*, in 1859 by Girard. Strecker (1909) described *Engystoma areolata* from a specimen in the collection of J. D. Mitchell taken in the Guadalupe River bottom, Victoria County, Texas. Wright and Wright (1933) recognized three species in the United States: *Gastrophryne areolata*, *G. carolinensis*, and *G. texensis*. In the same year Smith referred

G. texensis to the synonymy of *Gastrophryne olivacea*. Parker (1934) combined the New World genus *Gastrophryne* with the Old World *Microhyla*, although Stejneger and Barbour have preferred to retain *Gastrophryne*. Burt (1938a) attempted to show that *Microhyla areolata* (Strecker) was a synonym of *Microhyla olivacea* (Hallowell). Recently Taylor (1943) has described *Microhyla mazatlanensis* based on three specimens from Mazatlán, Sinaloa, Mexico, and this name must be considered in this survey.

DIAGNOSTIC CHARACTERS

At the beginning of the present investigation measurements were tabulated and various ratios were calculated. However, these were found to be of no diagnostic value, not only because relative proportions

change with age, but also because it is difficult to make precisely comparable measurements on specimens preserved in divers ways. Nevertheless, head width, head length, and snout to vent length are

of interest even though their diagnostic value is negative. The only characters found to be of taxonomic value were those of coloration. Burt (1938a) separates two supposed species, *M. carolinensis* and *M. olivacea*, with which he synonymized *areolata*, as follows:

"Upper surface light greenish or gray, usually without dark blotches or other markings; Texas, except extreme eastern part. *Microhyla olivacea*.

"Upper surface darker, often chocolate-colored or tan, usually blotched or other markings; extreme eastern Texas. *Microhyla carolinensis*."

Whereas these differences are useful in separating Texan specimens, an additional population west of the continental divide must also be considered. The three forms may be contrasted in tabular form as follows:

<i>carolinensis</i>	<i>olivacea</i>	<i>mazatlanensis</i>
1. Ventral surface mottled (fig. 1)	1. Ventral surface immaculate or with scattered melanophores (fig. 3)	1. Ventral surface with scattered melanophores (fig. 5)
2. Dorsum dark (brown, silvery gray) and blotched above or markings obscured by dark background, sometimes with dorsolateral stripe, indistinct or if distinct bordered by a dark margin (fig. 2)	2. Dorsum light (usually tan), not blotched, rarely with dark spots, a faint bar sometimes present on femur and tibia (fig. 4)	2. Dorsum light tan or grayish with at least some spots, a distinct bar on femur and tibia (fig. 6)

INTERGRADATION

A. BETWEEN *carolinensis* AND *olivacea*: The pattern on the ventral surface provides the simplest basis upon which a separation of the forms *carolinensis* and *olivacea* can be predicated, and it is in this character that intergradation can best be shown. In specimens of *olivacea* from the western periphery of its range, the ventral surface is immaculate. The number of melanophores appearing on the ventrum increases on specimens from localities farther east.

Populations including individuals representing both types of pigmentation occur in Victoria County, Texas, and in Latimer County, Oklahoma. Specimens from the same localities were found to have an intermediate combination of characters, ventral pigmentation being present in the form of mottling on the throat and sides of the abdomen (see figs. 7 and 8). The Victoria County series in the United States National Museum (U.S.N.M. Nos. 23133, 23744-23746, 23942, 42317-42331, 42333-42339, 42341, 51509, 78645-78659, 78662-78683, 78691-78695) includes normal *M. carolinensis*, and *M. olivacea* as well as a large series of intermediates. The following is a tabulation of the three types of individuals

from localities in Victoria County where both forms have been taken:

	<i>olivacea</i>	<i>carolinensis</i>	Intermediates
Guadalupe River bottom	0	0	7
Collette Creek	1	6	18
Victoria	4	3	16
TOTALS	5	9	41

Converted into percentages we find that 9 per cent are *olivacea*, 16 per cent are *carolinensis*, 75 per cent are intermediates. Specimens from Latimer County, Oklahoma, examined include U.M.Z. Nos. 73208, 73209, 77596, 77597, in which series of both *M. carolinensis* and *M. olivacea* as well as intermediates also occur. In this series there are three *olivacea*, one *carolinensis*, and six intermediates or, in terms of percentages, 30 per cent, 10 per cent, and 60 per cent, respectively. It is not known whether any selection was exercised by the collectors of these series.

There is geographic variation in the ventral pattern of *M. carolinensis* which complicates the situation. Some specimens from central and northern Florida

have a large non-pigmented area on the abdomen while on others many smaller non-pigmented areas have coalesced. In the Florida Keys this condition has reached its extreme development. In the southernmost Keys the amount of ventral pigmentation decreases. At Key West there is marked reduction in ventral mottling, so much so in fact that some specimens (29 per cent) closely resemble the western form, *olivacea* (see fig. 9). A few specimens have the normal *carolinensis* ventral pattern.

Examination of metamorphosing tadpoles of *carolinensis* in the Cornell University collection discloses ventral mottling on individuals in which limbs were beginning to emerge. Prior to the development of limbs, the ventral surface is immaculate. No material of comparable larval stages of *olivacea* has been available.

In *olivacea* the dorsum is unblotched in specimens from the western parts of its range. However, on the eastern edge of the range dark brown blotches appear on the tan dorsum, usually in specimens having some ventral pigmentation. The type of *Engystoma areolata* Strecker (U.S.N.M. No. 38999) has these dark blotches on the dorsum as well as definite traces of the ventral mottled pattern. The dorsal blotches are more characteristic of *carolinensis* on which they are not always evident, however, because of the darker ground color. Since the only specimens of *areolata* in collections all come from the region of intergradation, we regard the type and similar specimens as intergrades.

Throughout the range of *carolinensis*, occasional individuals are found that have two light dorsolateral stripes, but these occur more frequently in extreme southern Florida. In populations in the Florida Keys, three principal patterns are evident which may be segregated as follows: (a) the "Key West" form in which the dorsal pattern consists of two prominent, light tan, dorsolateral stripes, bordered by a distinct dark margin on a tan background, with the ventrum mottled (see fig. 11); (b) the *olivacea*-like form, virtually without a pattern so that specimens have a uniformly light tan dorsum, with the ventral coloring

usually much reduced (see figs. 9 and 10); (c) a third form includes individuals like mainland *carolinensis*, in which the dorsum may be dark and blotched or with indistinct dorsolateral stripes (without black margins) and the ventrum mottled. Most specimens from Lignum Vitae Key (U.S.N.M. Nos. 95716-95720), the northernmost of the Keys from which material has been available, have the ventral and dorsal pigmentation of mainland *carolinensis*; only one from this Key resembles the *olivacea*-like specimens. Of two individuals from Big Pine Key (U.S.N.M. Nos. 95827 and 85454) one is most nearly like "Key West" whereas the other is *olivacea*-like. One from Cudjoe Key (U.S.N.M. No. 95825) is likewise similar to *olivacea* in pattern characters. Without difficulty it is possible to assign each specimen from the Keys to one of the three forms described.

Referring to the first form as the "Key West" pattern, the second as *olivacea*-like, and to the third as *carolinensis*, we find that the three types of individuals inhabiting the Keys (arranged from north to south) may be tabulated as follows:

	<i>carolinensis</i>	"Key West"	<i>olivacea</i> -like
Lignum Vitae	6	0	1
Big Pine	0	1	1
Cudjoe	0	0	1
Key West	3	18	8
TOTALS	9	19	11

Converted to percentages, therefore, we find in the Florida Keys a heterogeneous population in which 23 per cent have mainland *carolinensis* characters and 48 per cent have the "Key West" pattern, whereas 29 per cent are *olivacea*-like.

The *olivacea*-like individuals differ not only in the dorsal pattern but in the ventral pattern as well, indicating perhaps a greater genetic difference between them and the mainland form than between the "Key West" sort and mainland *carolinensis*. However, in view of the locality data for the small samples available it is a reasonable assumption that individuals with the various patterns interbreed as indicated by intermediates. Conceivably some de-

gree of ecological isolation could exist, although this seems unlikely.

B. BETWEEN *olivacea* AND *mazatlanensis*: Taylor (1943) described *Microhyla mazatlanensis* from specimens collected at Mazatlán, Sinaloa. These same specimens he had previously called *Microhyla olivacea* (1938). From the diagnosis given, little can be found that warrants the description of a new form although the form appears to be recognizable on the basis of pattern characters. He states in part: "Related to *Microhyla olivacea* but distinctly smaller in size, the head a little narrower, the snout projecting more, a little more flattened above and rounding at the tip." Without more precise data this diagnosis is virtually without meaning. Snout to vent measurements of the type and paratypes are 22.2 mm., 23.3 mm., and 24.8 mm., respectively, and thus fall within the size range of *olivacea*. Presumably the series is composed of small adults, and it is for this reason that the head appears to be narrower and the snout longer. It has been observed that smaller specimens of both *carolinensis* and *olivacea* tend to have more acute snouts and relatively narrower heads than adults approaching full maturity and maximum size.

Perhaps the most useful data given are those in the color description: "Above nearly uniform brown with some scattered black spots tending to form a pattern medially; a broken black line begins behind the eye and continues to some distance on the side; trace of an inguinal spot, which together with a single bar or spot on

the femur, the tibia, and feet, form a continuous line when the limb is folded. Venter cream, with a very slight peppering of pigment on the chin; sides slightly mottled with lighter and darker; underside of the feet purplish brown, and the hands similarly colored, but to a lesser extent."

The black-spotted dorsum, the "peppered" ventrum (referred to in this paper as traces of mottling or the presence of scattered melanophores), and the continuous bar formed by the markings on the femur and tibia by the folded limb would seem to indicate that Taylor's *mazatlanensis* is virtually identical with the specimens from Peña Blanca Springs, Santa Cruz County, Arizona (U.M.M.Z. Nos. 75737, 75738, totaling 15 specimens), and those from Sonora 10 miles north of Pilares (U.M.M.Z. No. 78333), Guirocoba (A.M.N.H. Nos. 51244-51247), and Noria (U.M.M.Z. Nos. 72174-72177) which have these same markings (see figs. 5 and 6). The individual from Pilares, Sonora (U.M.M.Z. No. 78333), lacks a distinct bar on the femur and tibia, and the blotches on the dorsum are not prominent, although the ventral "peppering" is present. Likewise some specimens of *olivacea* (see fig. 4) have leg spots so arranged that a bar is formed on the tibia and femur as in individuals from Edinburgh, Texas (C.U. Nos. 2302, 2303), Gage County, Nebraska (A.M.N.H. No. 52155), and from Musquiz, Coahuila (C.N.H.M. Nos. 403-405). In some respects these specimens are intermediate between *mazatlanensis* and *olivacea*.

SIZE AS A TAXONOMIC CHARACTER

Snout to vent measurements were made on all specimens to ascertain whether there were any size differences between the forms. As in some other microhylids, the sexes can be separated in most cases by the blackish throat that appears to be present only on mature males. Most males develop these blackish throats by the time they attain a length of 22.5 mm., so this was used arbitrarily as the minimum adult size for females.

In order to ascertain the validity of this

means of determining the sex, 55 specimens (including 25 *olivacea* and 30 *carolinensis*) were dissected. Ten per cent of those without black throats were males of adult size, although every dark-throated individual (26 of the total) was a male.

Wright and Wright (1942) state that males of *carolinensis* range in size from 20 to 30 mm., females from 22 to 36 mm. For *olivacea* they give the following figures: males, 20 to 28 mm.; females, 19 to 29.5 mm. It would appear from these figures

that *carolinensis* females are much larger than individuals of *olivacea* of the same sex, suggesting that this might be another difference between the two forms. *Microhyla mazatlanensis* is diagnosed by Taylor as being "distinctly smaller" than *Microhyla olivacea*. However, when the means of snout to vent measurements of specimens allocated by us to the three forms (as well as the figures Taylor gives) are compared they show that this is not so.

Snout to vent measurements (in mm.) of

	275 <i>carolinensis</i>	105 <i>olivacea</i>	27 <i>mazatlanensis</i>
Males	26.0 (22.5-33.5)	27.1 (22.5-33.0)	26.0 (22.5-28.0)
Females	27.5 (22.5-36.5)	28.1 (22.5-38.0)	27.7 (22.5-30.0)

adults exceeding 22.5 mm. permit comparisons in tabular form, with sexes segregated only on throat color characters. The differences between the means (extremes in parentheses) are negligible, although size differences between the sexes are evident. Specimens without dark throats comprise roughly 50 per cent of each sample.

From these figures it is concluded that size is of no importance as a taxonomic character.

DISTRIBUTIONS

Microhyla c. carolinensis is primarily an inhabitant of the Austroriparian biotic province of the southeastern United States as defined by Dice (1943), although it ranges northward into the Carolinian and Illinoian provinces. The eastern narrow-mouthed toad occurs from Cove Point, Calvert County, Maryland (A.M.N.H. Nos. 43999, 44000, 45290, 45291), along the coastal plain south to Florida. In Virginia, North Carolina, South Carolina, Georgia, and Alabama this frog occurs from the Piedmont to the coast with some records in the latter three states for the mountains. It has been taken in five scattered counties in Tennessee (Sullivan, McMinn, Hamilton, Henry, and Shelby), and in Kentucky from Warren County (Barbour, 1941) as well as from Mammoth Cave National Park, Edmonson County (U.S.N.M. Nos. 118379, 118380). Dickerson (1906) records *carolinensis* from southern Illinois, but no specimens are available to substantiate the statement. Cagle (1941) states that *carolinensis* is not known from Illinois but "may be expected in the extreme southern part" of the state. Hurter's specimens from St. Louis County, Missouri (U.S.N.M. Nos. 57700, 57701), are north of the latitude in which southern Illinois lies, but on the western side of the Mississippi River. It seems not improbable therefore that this frog occurs in southern Illinois. *M. c. carolinensis* is also

generally distributed in Mississippi, Louisiana, and eastern Arkansas, but in Missouri is known only from St. Louis, Butler, and Barry counties. In Texas, it is known from Lamar, Liberty, Bowie, Shelby, Harris, Galveston, and Victoria counties. Interbreeding with *olivacea* is assumed to occur in Victoria County, Texas, and Latimer County, Oklahoma, as indicated by the presence of intermediates.

The second race, *M. c. olivacea*, occurs within no fewer than five biotic provinces as defined by Dice (*supra cit.*); it is generally distributed in eastern and central Kansas and Oklahoma (except for the Panhandle) and in central and southern Texas, with one record as far west as Jeff Davis County (Wright and Wright, 1942). It is also known from Gage County, Nebraska (Loomis, 1945), and from Jackson, Cass, and Platte counties, Missouri (Anderson, 1941). In Mexico it has been taken at the following localities: Musquiz (C.N.H.M. Nos. 402-405, 28699-28704, 28759) and Torreon (Taylor, 1940) in Coahuila; Progreso, Rio Santa Maria, Chihuahua (U.S. N.M. No. 105161, a badly mutilated specimen which appears to be *olivacea*); Conejos in Durango (Taylor, 1940).

The third race, *Microhyla c. mazatlanensis*, probably is generally distributed in the foothills of northwestern Mexico (Sinaloa and Sonora) barely ranging into southern Arizona; roughly its range may

be said to occupy the eastern portion of the Sonoran and the northern portion of the Sinaloan biotic provinces as mapped by Dice (*supra cit.*). If our belief concerning the identity of the type is correct, *mazatlanensis* is known from the following localities: Mazatlán, Sinaloa (type locality); 10

miles north of Pilares, 5 miles north of Noria, and from Guirocoba in Sonora; and Peña Blanca Springs, in Santa Cruz County, Arizona. Except for the type and paratypes all the other specimens reported have been examined.

DISCUSSION

The data presented above indicate that populations with pattern characters ranging from those of typical *carolinensis* to those of typical *olivacea* occur in southern United States and northeastern Mexico with a third population, *mazatlanensis*, on the other side of the continental divide. The transition between *olivacea* and *carolinensis* presumably occurs along a line from Victoria County, Texas, to Latimer County, Oklahoma, where intermediates (including the type of *Engystoma areolata*) are found. Farther west, there is no evidence of any dichotomy in characters between *olivacea* and *mazatlanensis*. Rather, the differences between the two populations are mean differences, with no abrupt transition. The single specimen from Pilares in northeastern Sonora has characters of both *mazatlanensis* and *olivacea*, and presumably a series of annectant populations ranges across the continental divide. This is possible since a number of amphibians and reptiles range across the divide in this region, according to Bogert and Oliver (1945). It may be noted that the areas of intergradation between *carolinensis* and *olivacea* are in the same general region in which subspecies of mammals, reptiles, and other amphibians also intergrade.

The narrow intergradation area indicates either that *carolinensis* and *olivacea* are approaching complete isolation or that previously existing isolating mechanisms

have broken down. Pattern differences between these two forms, despite a lack of other morphological differences, indicate some degree of isolation. Whether the two populations can be called incipient species or whether the differences arose during previous isolations is a matter for speculation. Comparative life history studies dealing with populations in the critical areas in the range of this species may reveal other differences between the two forms and throw more light on the problem.

The small populations that exist in the Florida Keys would be described as a new subspecies by some workers. But there is no evidence of isolation or more than partial differentiation; only mean differences can now be detected. However, individual specimens of the population inhabiting the Keys are as distinct from *carolinensis* as *mazatlanensis* is from *olivacea*, but the situation for the population as a whole is anomalous. Scarcely a fourth of individuals from the Keys are like mainland *carolinensis*, 29 per cent are *olivacea*-like, and 48 per cent have the "Key West" pattern. Because interbreeding among the three types of individuals may be inferred on the basis of samples, pending better evidence to the contrary, we conclude that the populations on the Keys are not worth taxonomic recognition.

SUMMARY AND CONCLUSIONS

1. *Microhyla carolinensis* (Holbrook), *Microhyla olivacea* (Hallowell), and *Microhyla mazatlanensis* Taylor apparently interbreed where their ranges adjoin and therefore should be ranked as subspecies.

2. *Microhyla areolata* (Strecker) is not a straight synonym of *Microhyla olivacea* but represents an intermediate population between *carolinensis* and *olivacea*. There-

fore, it should be included under the synonymy of both forms.

3. What appears to be a poorly differentiated local population inhabiting the Florida Keys is composed of 29 per cent *olivacea*-like individuals, 48 per cent "Key West," and 23 per cent normal *carolinensis*. Because intermediates exist and because interbreeding presumably occurs between individuals of the three pattern phases, these heterogeneous populations in the Keys are referred to *M. c. carolinensis*. It is conceivable that each of the three pattern phases manifests a different habitat preference, but the locality data available for the specimens examined are not sufficiently precise to determine this. Or isolating mechanisms that existed in the past may have broken down; it is not impossible that the overseas highway, which now connects the islands comprising the Keys, has permitted dispersals where previous geographical isolation existed. Further in-

vestigations in the Keys will be necessary to prove or disprove such assumptions.

KEY TO THE SUBSPECIES OF *Microhyla carolinensis*

1. Ventrums mottled.
 - A. Dorsum dark; dorsolateral stripe sometimes present, indistinct, or, if distinct, bordered by a dark margin *carolinensis*
2. Ventrums immaculate or with scattered melanophores.
 - A. A blotch or spots on the femur and tibia which form a bar or continuous line when the limb is folded; dorsum with dark spots. *mazatlanensis*
 - AA. Spots rarely present on the femur and tibia; if present usually not forming a distinct bar when the limb is folded; dorsum tan and generally without markings. *olivacea*¹

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¹ Some of the specimens from the Florida Keys will fall in this part of the key.

² This bibliography includes references cited as well as the sources of literature records included on the spot map.

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Fig. 1. Ventral view of mainland *Microhyla c. carolinensis*, C.U. No. 4733, from Jefferson County, Louisiana (male, $\times 3$).

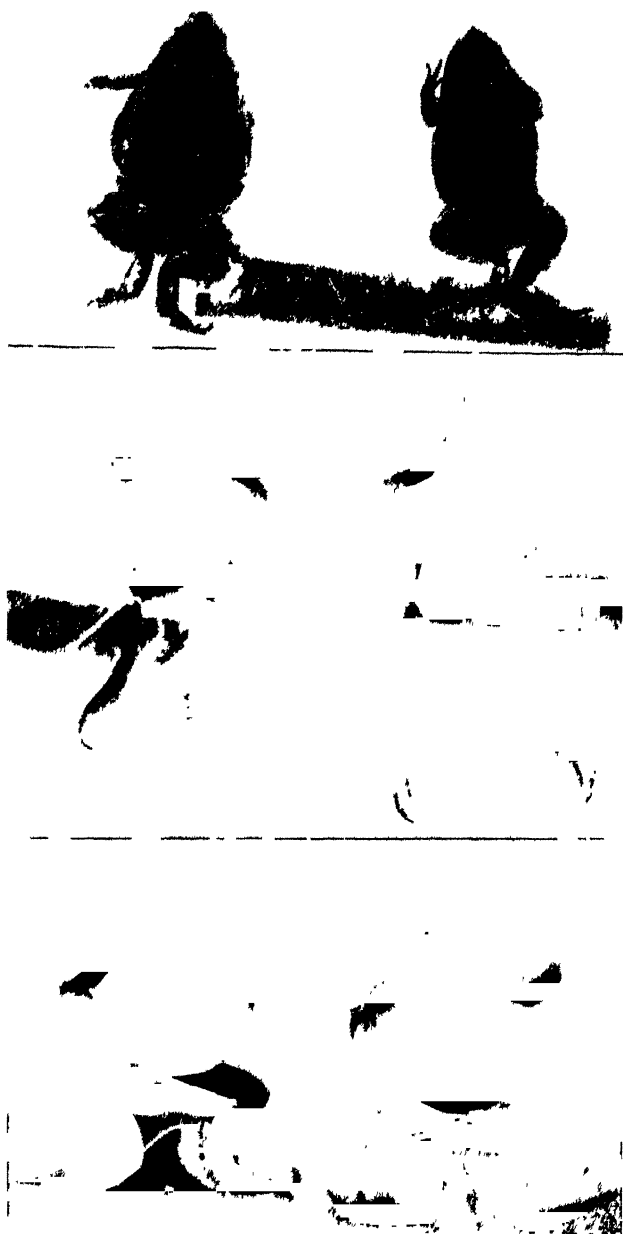


Fig. 2. Dorsal view of mainland *Microhyla c. carolinensis* (slightly enlarged). Upper row, A.M.N.H. No 51978, from Maxton, Robeson County, North Carolina; middle row, A.M.N.H. Nos. 52001, 52002, from Highlands County, Florida; lower row, A.M.N.H. Nos. 932, 933, from Stevenson, Jackson County, Alabama.



Fig. 3. Ventral view of *Microhyla c. olivacea* (slightly enlarged). Upper row, A.M.N.H. No. 52155 from 2 miles southwest of Barnston, Gage County, Nebraska, lower row, U.M.M.Z. No. 66866, from Bourbon County, Kansas.



Fig 4. Dorsal view of *Microhyla c. olivacea* (slightly reduced) showing the variation in the development of the leg bar. Upper row, C.N.H.M. Nos. 402, 403, 405, from Musquiz, Coahuila, Mexico, middle row, A.M.N.H. No. 52155 from 2 miles southwest of Bainston, Gage County Nebraska, lower row, U.M.M.Z. No. 66866, from Bourbon County, Kansas.

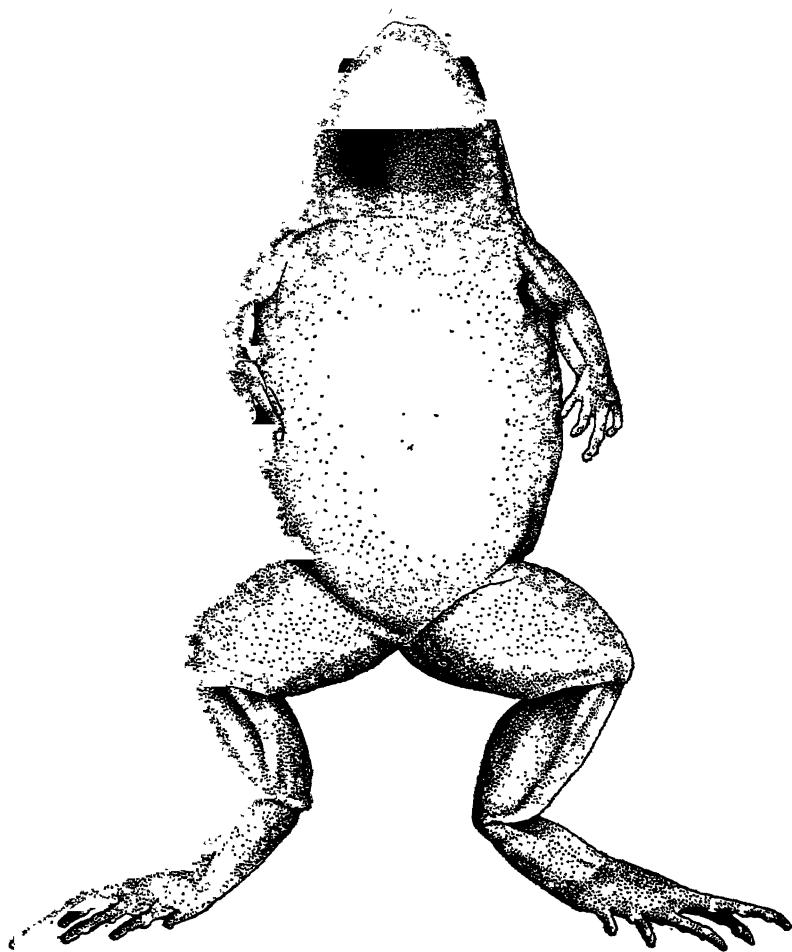


Fig. 5. Ventral view of *Microhyla c. mazatlanensis*, A.M.N.H. No. 51245, from Guirocoba, Sonora, Mexico (male, $\times 3$).



Fig. 6. Dorsal view of *Microhyla c. mazatlanensis*, U.M.M.Z. No. 72176, from Noria, Sonora Mexico (male, $\times 3$).

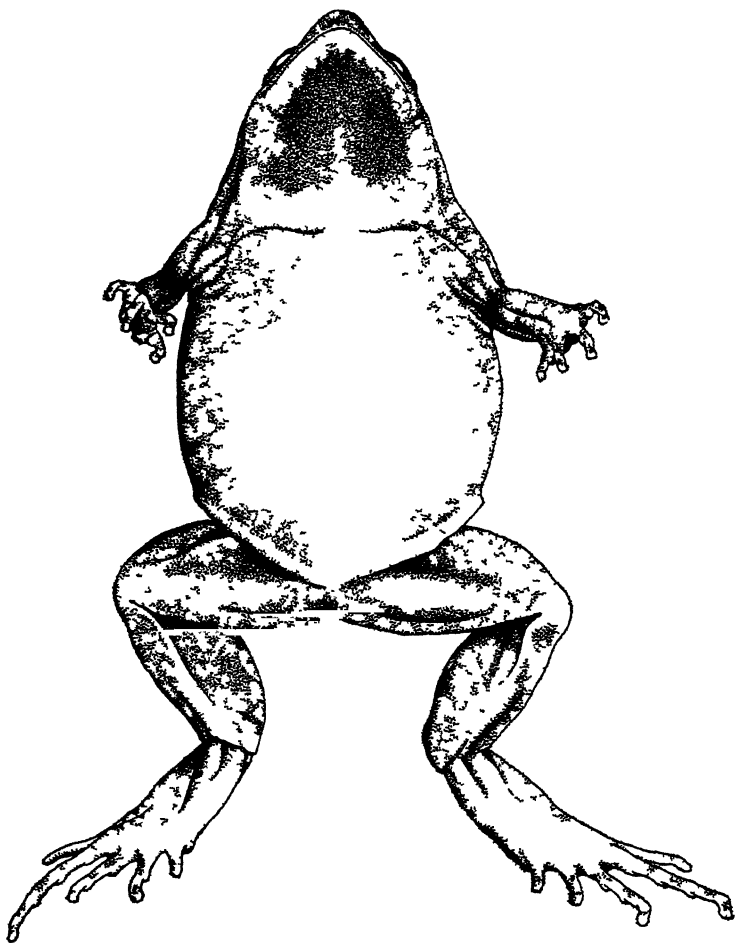


Fig 7. Ventral view of *Microhyla carolinensis-olivacea* intergrade, U S N M. No 42338, from Victoria County, Texas (male $\times 3$)

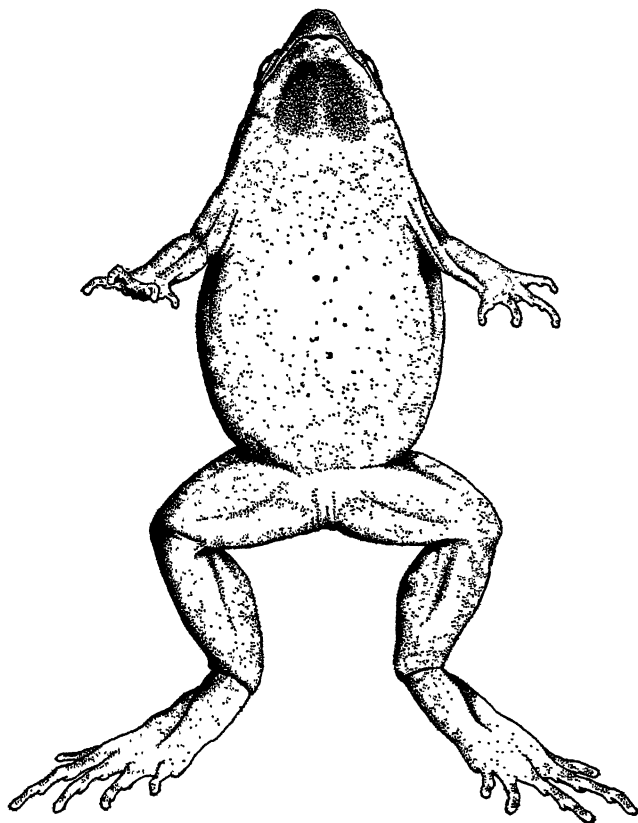


Fig. 8. Ventral view of *Microhyla carolinensis-olivacea* intergrade, U.S.N.M. No. 42325, from Victoria County, Texas (male, $\times 3$).

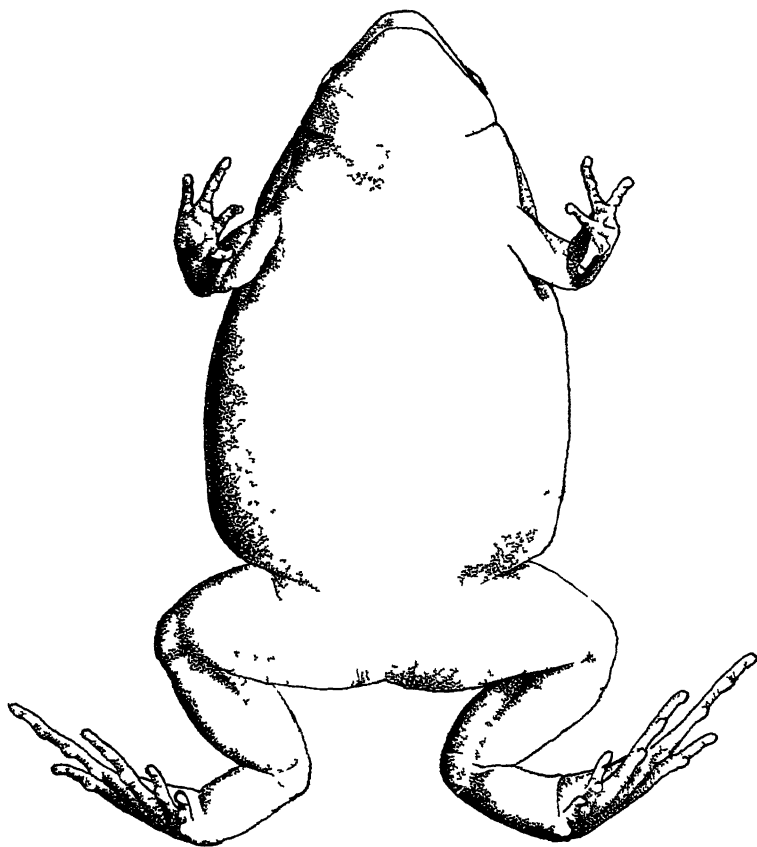


Fig 9 Ventral view of olive-like *Microhyla c. carolinensis*, U.S.N.M. No. 83472, from Key West, Florida (female $\times 3$)

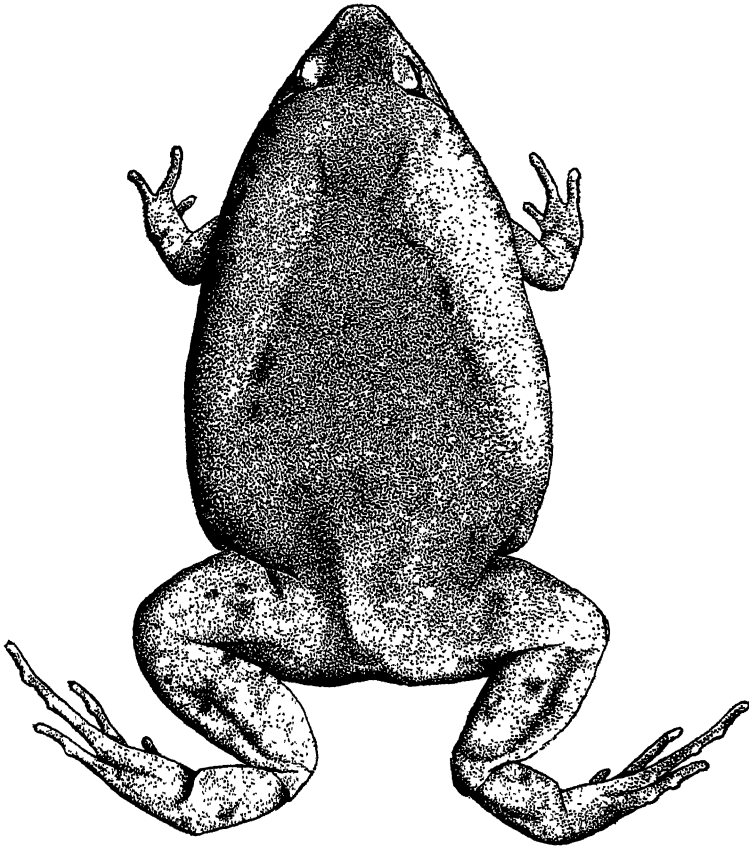


Fig. 10. Dorsal view of *olivacea*-like *Microhyla c. carolinensis*, U.S.N.M. No. 83472, from Key West, Florida (female, $\times 3$).

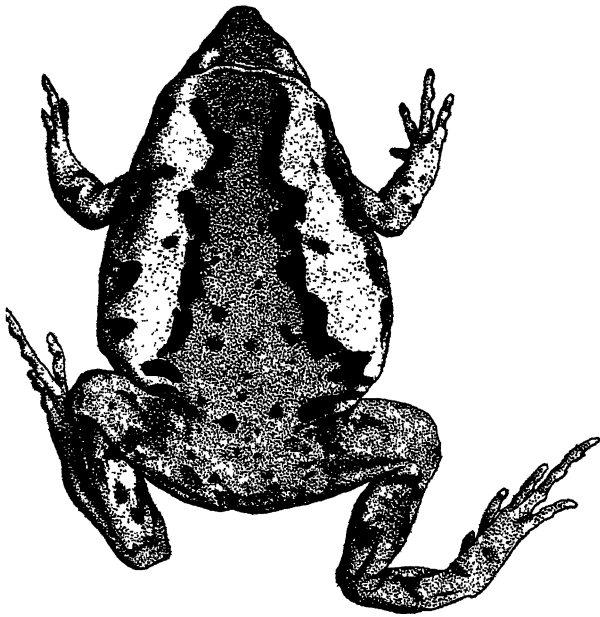


Fig. 11. Dorsal view of individual with "Key West" pattern referred to *Microhyla c. carolinensis*, U.S.N.M. No. 85447, from Key West, Florida (female, $\times 3$).

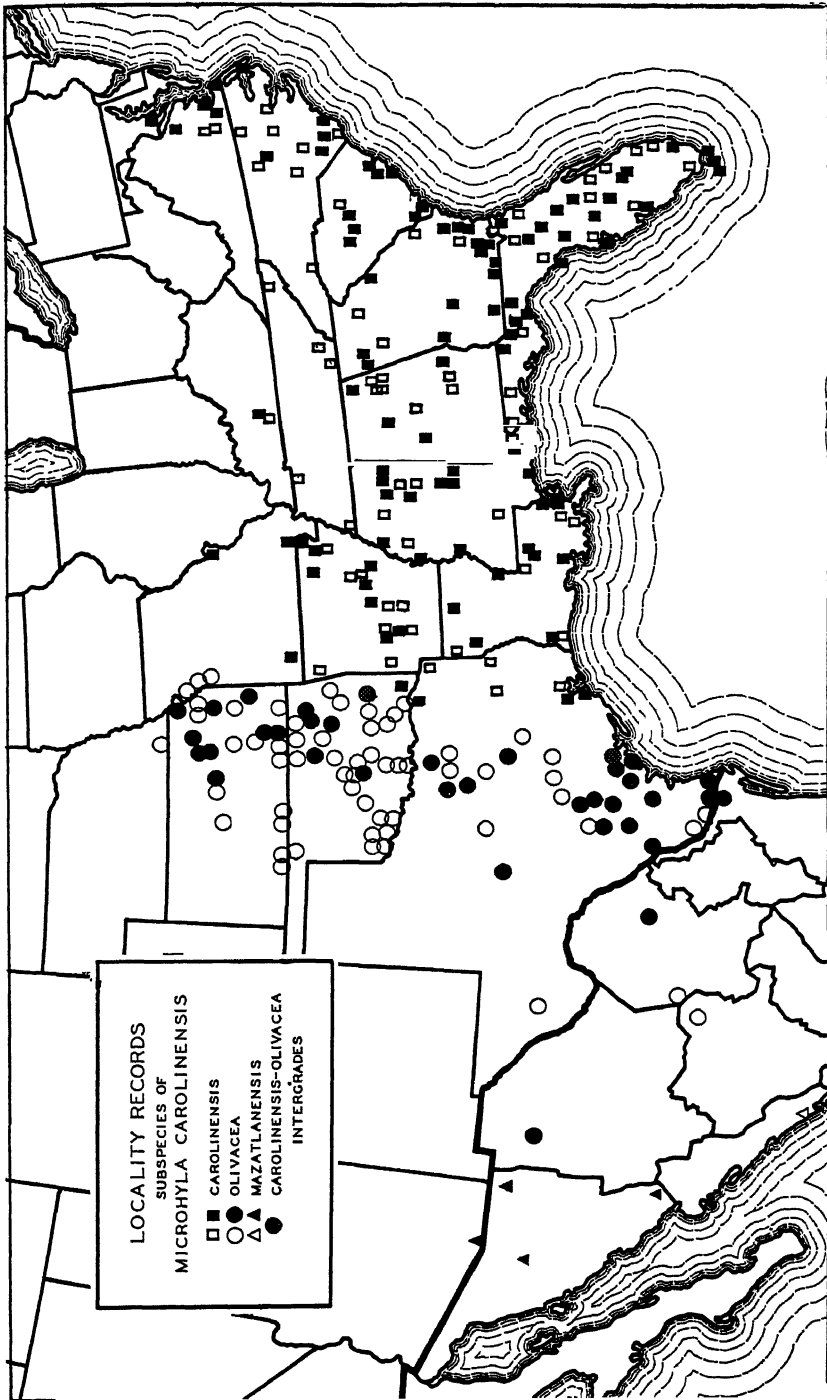


Fig. 12. Map of middle North America showing the distribution of the subspecies of *Microhyla carolinensis*. Solid symbols represent localities for material examined; hollow symbols represent literature reports

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THE ANTERO-SUPRAGNATHAL OF *GORGONICHTHYS*

By DAVID H. DUNKLE¹ AND PETER A. BUNGART¹

INTRODUCTION

Newberry proposed the generic name *Titanichthys* in 1885 for the remains of a spectacularly large arthrodiran fish from the upper Devonian Ohio Shales formation. During the ensuing 60 years, bones referable to the genus have proved to be as commonly encountered in collecting throughout the northern Ohio field as are those of the various, more widely and more popularly recognized species of *Dinichthys* which occur contemporaneously in the same formation. *Titanichthys*, in consequence, has become well established as a distinctive member of the fish fauna of the Ohio Shales, and although no thorough revisionary work has been attempted for many years, six species are tentatively assigned to the genus at the present time. Despite this, the details of titanichthyid structure are still very imperfectly understood. Peculiarly modified in a bottom-feeding adaptation (Dunkle and Bungart, 1942), many of their skeletal elements are, in addition, so excessively thin that they cannot be removed from the matrix. An inability to observe either the presence or absence of the usually characteristic sensory canals and the number and nature of overlap areas by adjacent bones often makes impossible the determination, as to particular skeletal part, of isolated specimens. More important, these conditions of preservation and unfamiliar modification have led to a complete failure to recognize for *Titanichthys* any of the supragnathal elements and some of the dorsal and ventral body armoring plates.

In connection with one of these latter unsolved structural issues, the first definitive

identification of the upper mouth parts of *Titanichthys* was announced by Dr. Louis Hussakof (1930) before the twenty-first annual meeting of the Paleontological Society at Washington, D. C. Unfortunately neither figures nor formal description of the specimen have subsequently appeared. A meager abstract, as the only published account of this report, has remained a source of intriguing interest to all students of the Arthrodira.

Recently, Mrs. John Bull, working among the collections of fossil fishes in the American Museum of Natural History under the direction of Dr. Edwin H. Colbert, came upon two associated bones which bear the identifying labels, respectively, of a "left antero-supra-gnathal" and indeterminate "cranial bone" of *Titanichthys*. These were submitted to and gratefully received by the present writers. Careful comparisons with the abstract indicate the bones to be those on which Hussakof based his original report. They (A.M.N.H. No. 7908) were collected by Peter A. Bungart in 1910 from exposures of the Cleveland Shale member of the Ohio Shales formation on the shore of Lake Erie, 1/2 mile east of the Avon Plant of the Cleveland Electric Illuminating Company in Avon Township, Lorain County, Ohio. The specimen is here described and figured for the first time because the characters of the supragnathal element preclude its reference to the genus *Titanichthys*, as do also those of the "cranial plate" which is revealed as a fragmentary anterolateral plate. These specimens are here referred to *Gorgonichthys*.

These writers sincerely appreciate the

¹ The Cleveland Museum of Natural History, Cleveland, Ohio.

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DESCRIPTION

The present specimen consists of two bones: one, a left antero-supragnathal; and the other, as here interpreted, a fragmentary right anterolateral plate. The outlines and relationships between the separate parts of these two bones are illustrated in figures 1 and 2, respectively.

section, and is also convex, although to much less degree, in any parasagittal plane. Its internal surface is concave in both of these respective sections.

The lateral lamina of the antero-supragnathal comprises the main body of the element. With regard to general shape, it

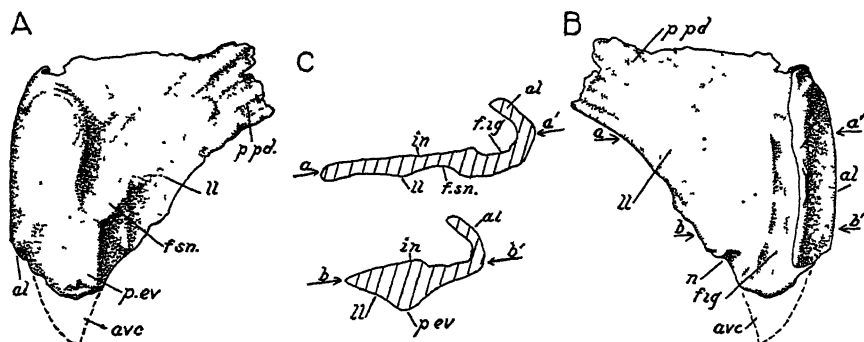


Fig. 1. *Gorgonichthys clarki* Claypole (A.M.N.H. No. 7908). Left antero-supragnathal in (A) lateral aspect, (B) mesial aspect, and (C) frontal sections. Reproduction approximately $\times 1/8$. a-a', Plane of frontal section (C) indicated on B; al, mesially directed anterior lamina of the antero-supragnathal; avc, anteroventral cusp, b-b', plane of frontal section indicated on B; f.ig., incised area worn by the anterodorsal cusp of the inferognathal; f. sn., fossa for the articulation with the subnasal element; in, internal surface of the antero-supragnathal; ll, longitudinally directed lateral lamina of the antero-supragnathal; n, notch on posteroventral margin of the element worn by the oral margin of the opposing inferognathal plate; p. ev., external vertical ridge marking the thickening of the anteroventral cusp, and p. p.d., backwardly directed posterodorsal extremity of the antero-supragnathal.

The antero-supragnathal possesses an over-all length of 207 mm. The maximum depth of the element, as preserved, is 194 mm. Its ventral cusp, however, is incomplete, and the total restored height should approximate 230 mm. Typically arthroduran in development, the plate may be said, for purposes of description, to be composed of anterior and lateral laminae which are united anterolaterally in an externally rounded angle of less than 90 degrees.

The anterior lamina, quadrangular in outline from forward view, exhibits a depth of more than three-quarters the total restored height of the bone. The width of this mesiad extension is less than one-fourth the maximum depth. The external face of the part is acutely convex in frontal

is roughly triangular in either lateral or lingual views with the slightly concave posteroventral margin the longer of the three sides, and the posterodorsal angle truncated. This plate-like expanse of bone is so situated that its broad internal and external surfaces are vertically inclined. The thin, although relatively deep, posterodorsal extremity shows little mesial curvature, but is extended virtually straight backward. Anteroventrally, a stout cusp is developed whose thickening is marked by a vertical ridge, externally. Worn internally by the ventrally opposing inferognathal, the cusp is triangular in frontal section. This cusp development, in so large a plate, is restricted to a surprisingly low ventral area. Immediately

above the external vertical ridge of the thickened cusp a depression is displayed whose margins diverge dorsally across both the anterior and lateral laminae of the bone. Similar concavities occur on the antero-supragnathals, where known, of all the dinichthyid arthrodines. They mark the areas

row, and deeply incised area forward from the ventral cusp of the antero-supragnathal resulting from wear by the anterodorsal cusp of the inferognathal. Finally, the posteroventral margin of the plate is angularly notched just behind the antero-ventral cusp in a manner indicative of an

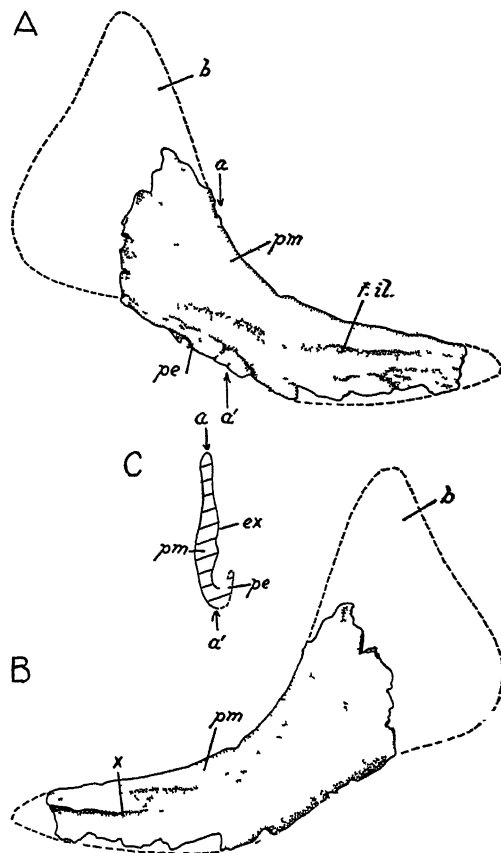


Fig. 2. *Gorgonichthys clarkii* Claypole (A.M.N.H. No. 7908). Fragmentary right anterolateral plate in (A) lateral aspect, (B) mesial aspect, and (C) transverse section. Reproduction approximately $\times 1/6$. a-a', Plane of transverse section (C) indicated on A; b, restored posterodorsal expansion of the anterolateral plate; ex, external face of the element; fil., rugose surface on the external surface of the mesial arm for the articulation of the interolateral plate; pe, lateral anteroventrally projecting arm; pm, mesial anteroventrally projecting arm; and x, unexplained rugosities on the inner face of the mesial arm.

for articulation with the paired sub-nasal elements which will be fully described and determined as anterior ossifications of the primary palatoquadrate complex in a forthcoming paper by the present writers. Lingually, the surface of the lateral lamina is featureless except for a very high, nar-

externally overlapping opposition upon a decidedly obtuse inferognathal oral margin.

As regards the second of the two bones comprising the present specimen, the determination of fragmentary arthroduran bones as to particular skeletal part is often admittedly hazardous. In this case, how-

ever, the recognition of definite structures is possible, and this redetermination of the erstwhile "cranial plate" as an anterolateral element is considered of unquestionable validity.

The preserved crescentic portion represents the anteroventrally projecting limbs of an anterolateral plate of the type known to be possessed by *Gorgonichthys*, *Heintzichthys*, and *Titanichthys* (Dunkle and Bungart, 1940; Heintz, 1931). In these genera the external arm of the anterolateral elements, well developed and bearing spinal plates in *Coccoosteus* and the members of the *Dinichthys terrelli* group, is reduced to a laterally upfolded flange, in varying degrees of completeness, on the ventral margin of the mesial arm. In addition, these genera invariably exhibit the rugose overlap area on the lateral face of the mesial arm which marks the articulatory surface for the interolateral plate. Both of these structural evidences are to be observed on

this particular specimen, and support our convictions as to the identity of the fragment. It may be noted that the lateral arm vestige, depicted in figure 2, is very weakly developed and that the main body of the element, paralleling the concave anterodorsal margin, is only moderately thickened. At present the rugosities displayed on the inner face of the mesial arm are not explained, although they are undoubtedly concerned with the cartilaginous primary shoulder girdle. Worthy of mention, also, is the general delicate structure of this anterolateral plate compared with the truly massive and powerful dentition which the associated antero-supragnathal denotes. This apparently reflects a tendency toward the further reduction of the dorsal body armor following the phylogenetic loss, in turn, of the connection between dorsal and ventral armor, the spinal elements, and, finally, the lateral anteroventral arm of the anterolateral plates.

REMARKS

As may be gathered from the above description, the characters of the present two bones are identical with those of the corresponding elements of the genus *Gorgonichthys* Claypole (1892), as recently redefined (Dunkle and Bungart, 1940). Briefly discussed below, the most pertinent of these characters would be clearly distinguishable from *Titanichthys* even without prior knowledge of *Gorgonichthys*, and show that these bones cannot possibly be referred to the former genus.

The antero-supragnathal plate exhibits three areas of extensive wear by the opposing inferognathal element. These are: the high, short, and deeply incised area on the internal face of the bone, anteriorly; the worn inner surface of the anteroventral cusp; and the deep, square notch behind the cusp on the posteroventral margin of the plate. Assuming that functionally worn supragnathal bones must necessarily reflect functionally abraded inferognathals, the above evidences of wear would seem to indicate the oral margin of an opposing inferognathal which bore below this antero-supragnathal an acute anterior "tooth," a

deep notch, and an obtuse cutting edge. These structures suit the conditions known for *Gorgonichthys*. In contrast, we have failed ever to observe conclusive evidences of functionally worn inferognathals among the titanichthyids. Further, a belief (Dunkle and Bungart, 1942) has been expressed that the inferognathal plates of *Titanichthys* have always been incorrectly interpreted—upside down and interchanged from side to side. By the proposed re-orientation, the anterior extremity of the titanichthyid inferognathal is directed ventromesially and is, in consequence, non-cuspidate orally.

As explained above, the structure of the fragmentary anterolateral plate is similar in basic pattern to that of *Gorgonichthys*, *Heintzichthys*, and *Titanichthys*. The overall dimensions of the bone, vestigial condition of the lateral anteroventrally projecting arm, and the moderate development along the longitudinal axis of the mesial anteroventral arm are details at variance with the anterolateral elements possessed by the last two genera, and definitely denote an identity with *Gorgonichthys*. We

are convinced of the correctness of the present determination for this specimen. While regrettable, it seems necessary to conclude that Hussakof's original assignment of this material was erroneous and to state that the supragnathal bones of *Titanichthys* remain unknown.

The initial proposal (Dunkle and Bungart, 1940) for the reestablishment of the Claypole term *Gorgonichthys* was based on composite but fairly complete materials in the Cleveland Museum of Natural History, but pertained as well to all the specimens correctly referred to the *clarki* species which had been assigned to the genus *Dinichthys* by Eastman (1900) and Hussakof (1905). As stated without elaboration in that preliminary study, a number of important questions concerned with the interpretation of structure and with the phyletic relationships of the form were left unanswered. Continued study on the arthrodiran fauna of the Ohio Shales has not appreciably forwarded the solution of any of these questions. Some clarification of the problems has resulted, however, and this moment seems opportune for the statement of certain of these unsolved points regarding the status of *Gorgonichthys*.

In brief survey, the few attempts at reconstruction of the phylogeny of the Ohio Shales Arthrodira have been based primarily on the characteristics of the gnathal elements, and of these the inferognathal plates have been used most widely. From the tentative groupings of forms that have been discussed in the literature, one gains the impression that the principal development among the typical dinichthyid arthrodires proceeded from older forms in the lower Huron Shale member of the formation with obtuse cutting-edged, posteriorly denticulate inferognathals of the *Dinichthys herzeri* type to culminating forms in the upper Cleveland Shale member with acute cutting-edged, posteriorly nondenticulate inferognathals of the *D. terrelli* type. In this arrangement, the inferognathals of the *clarki* species with excessively high anterior cusp, short, blunt cutting edge, and massive, posterior "denticles" and those of *Heintzichthys* with low anterior cusps, long, blunt cutting

edge, and no posterior "denticles" were considered aberrant Cleveland Shale derivatives of the Huron Shale *herzeri* type. Hussakof (1906) suggested the possibility that the blunt and acute cutting-edged inferognathal types represented two distinct developmental lines throughout the Ohio Shales formation, but discarded the theme in favor of the above pattern. An arbitrary practice thus obtained, by which the *D. terrelli*-like forms were restricted to the Cleveland Shale and any dinichthyid specimen found in the Huron Shale was automatically referred to *D. herzeri*.

This usage is no longer tenable. A gradual accumulation of more complete specimens has resulted through years of collecting. These, when studied in the light of the excellent advances made by our European colleagues in the fundamental interpretation of arthrodiran structure, have shown that the inferognathal elements merely express conditions of basic modification whose explanations must be found in other, associated skeletal parts.

In the above regard and based solely on the characteristics of the inferognathal plates, the more common dinichthyid arthrodires from the Ohio Shales appear separable into two groups. The first, which may be called the *Dinichthys herzeri* group, exhibits obtuse cutting-edged mandibular elements and includes, in addition to *D. herzeri*, *Gorgonichthys clarki*, *Heintzichthys gouldii*, and *Holdenius holdeni*. The second, here referred to as the *Dinichthys terrelli* group, possesses acute cutting-edged lower mouth parts, and includes, besides *D. terrelli*, the species *intermedius* and *curtus*.

With the exception of *Holdenius* in which the upper mouth parts remain unknown, the *herzeri* group all possess antero-supragnathal elements whose posterodorsal extremities are thin, high, and directed straight backward. In contradistinction, the posterodorsal extremities of the antero-supragnathals of the *Dinichthys terrelli* group are mesially recurved and greatly expanded. The significance of this feature has previously been touched on (Dunkle and Bungart, 1940) and is here illustrated in figure 3. Reminiscent of the relations

in acanthodians between the five small anterior ossifications with the anterior basal plate (Watson, 1937), the five supragnathal elements of certain dinichthyid arthrodires (single mediognathal, and paired antero-supragnathals and postero-supragnathals) are intimately associated with a parasphenoid-like plate in the ventral cranial basis. This latter bone, previously re-

margin excavated by a pair of deep concavities. From a correct alinement of all associated elements, the expanded postero-dorsal extremities of the *terrelli* type of antero-supragnathal are indicated to have had a direct abutting articulation into these pits. In contrast, as known for at least one of the *herzeri* group, *Heintzichthys gouldii*, the anterior portion of the anterior

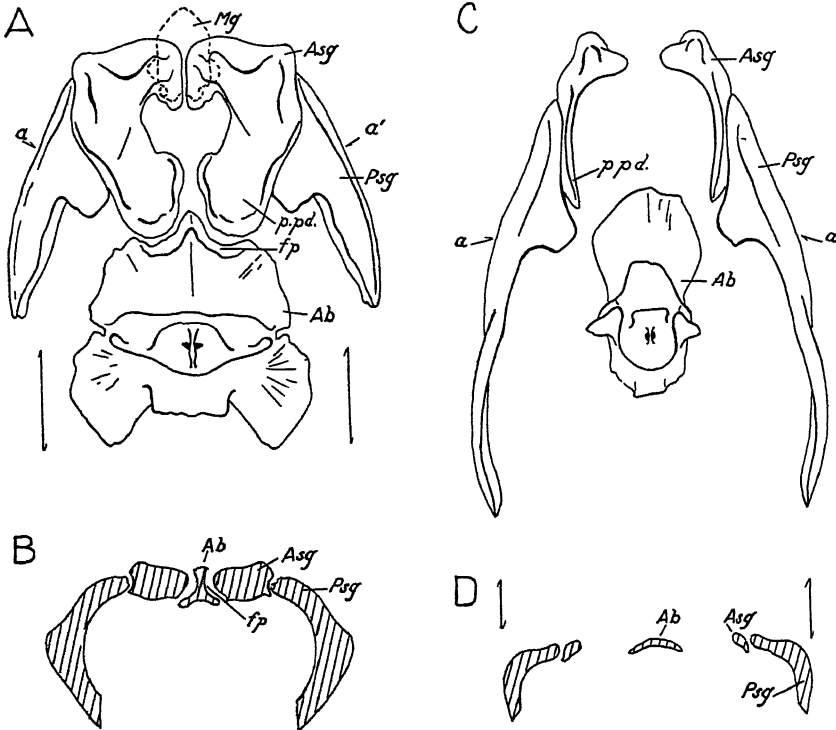


FIG. 3. Diagrams showing the arrangement of the supragnathal elements and anterior basal plate in dorsal aspect and in transverse section of (A and B, respectively) *Dinichthys terrelli* and (C and D, respectively) *Heintzichthys gouldii*. Reproduction of A and B approximately $\times 1/6$; and of C and D approximately $\times 2/3$. a-a', Planes of the transverse sections (B and D) indicated on A and C; Ab, anterior basal plate; Asg, antero-supragnathal plate; fp, concavities on the forward margin of the anterior basal plate; Mg, mediognathal plate superimposed in dashed lines in A but omitted on C; p. p.d., posterodorsal extremity of the antero-supragnathal plate; and Psg, postero-supragnathal element.

marked by Hills (1936) for *Coccosteus*, by Stensiö (1934; 1945) for various other arthrodires, and completely described for *Dinichthys terrelli* in a forthcoming paper by us, is apparently to be homologized with the anterior basal element of the acanthodians. This element in *D. terrelli* is thickened anteromesially and its forward

basal plate is a proportionately much narrower, thin lamina of bone, strongly arched dorsally. From observations on reconstructed specimens, the flange-like posterodorsal extremities of the *Heintzichthys* antero-supragnathal could not have had any direct articulation with that member, but apparently possessed a type

of overlapping arrangement, only, however, through the intermediary of a wide expanse of the cartilaginous braincase floor.

In addition to the above differences of gnathal and endocranial structures between the *terrelli* and *herzeri* groups, two of the designated members of the latter, *Gorgonichthys clarki* and *Heintzichthys gouldii*, possess in common a number of fundamental characteristics which are at wide variance with the corresponding structures of the *terrelli* group. These are: cranial shields lacking the massive transverse and longitudinal ventral thickenings, possessing proportionately larger orbital emarginations, indistinct postorbital processes, and relatively much shorter posterolateral marginal extent; reduced ventral keels on the mediodorsal plates; only vestigial lateral anteroventral arms on the anterolateral bones; apparent complete loss of spinal elements; and general reduction of the spinal processes of the antero-ventrolateral plates as well as of the entire ventral armor.

It may be remarked that comment on the modifications of the cranial shield and body armor of *Dinichthys herzeri* has been omitted in the above discussion. This has been a deliberate omission. Acute cutting-edged inferognathal plates which can pertain only to some member of the so-called *terrelli* group are frequently encountered in the Huron Shale. In fact, all the skeletal parts of the *terrelli* group exhibit so uniform and distinctive a combination of characteristics that in the opinion of these writers the vast majority of all known Huron Shale dinichthyid specimens must belong to the *terrelli* group. This fact would extend the geologic range of the *terrelli* group throughout the Ohio Shales formation, and necessitates the implication that *D. herzeri* is to be considered a rather rarely collected Huron Shale form whose dermal armor, except for the mouth parts, has not been recognized. Thus, in the absence of entirely complete specimens for the several designated members of the *herzeri* group, inference has been freely but necessarily employed in establishing the criteria for both the separation of the common Ohio Shales dinichthyids into the

terrelli and *herzeri* groups, and the demonstration that the *herzeri* group constitutes a natural unit. The common possession of basically similar gnathal elements need not mean that *D. herzeri* and *Gorgonichthys clarki* will prove to have anterior basal plates identical with those of *Heintzichthys gouldii*, and the cranial shield and body armor of *D. herzeri* need not exhibit the comparable modifications of those common to *G. clarki* and *H. gouldii*. However, the structure of the antero-supragnathal of *D. herzeri*, which militates against the conception of any arrangement of parts similar to that of the *terrelli* group, and the regular possession in all members of the *herzeri* group of certain comparable structural developments quite prohibit the dismissal of the present phylogenetic suggestions without serious consideration.

The above considerations reflect the admitted uncertainties with which *Gorgonichthys clarki* must still be regarded. The *clarki* species is without doubt generically distinct from the members of the so-called *terrelli* group. However, the as yet incompletely revealed *herzeri* species, from which *G. clarki* is presumably derived, is the genotype of *Dinichthys*. Until *D. herzeri* is more adequately understood, the removal of the *clarki* species from the genus *Dinichthys* and the proposal for the re-establishment of the term *Gorgonichthys* for its reception are based on inconclusive evidence. Despite this, the provisional recognition of the *clarki* species as a distinct morphological type is advocated by us because of the peculiar modifications of its skeletal complex and the measurable differences between its gnathal elements and those of *D. herzeri*. These latter structural adaptations are, in part, illustrated by the following attempted analysis of the jaw mechanism.

The gnathostomous character of placoderm jaws has been established through many recent studies by Gross, Heintz, Stensiö, Watson, and others. Based on these fundamental interpretations the present writers have determined that the first visceral arch among the dinichthyid arthrodires ossified in four centers. The antero-inferognathal and postero-infero-

gnathal represent, respectively, anterior and posterior ossifications of the Meckelian segment of the arch. The presumed dermal inferognathal plate is borne dorsally astride with its anterior end lateral and its posterior extremity mesial to these primary mandibular elements. The sub-nasal bone, referred to above, and the post-suborbital element represent, respectively, anterior and posterior ossifications of the dorsal palatoquadrate portion of the arch. Similarly, thickened protuberances on the lateral face of the postero-inferognathal and on the inner face of the post-suborbital seem to indicate a movable articulation between these two elements, and liken them to articular and quadrate, respectively. Some evidences exist (Dunkle and Bungart, 1945) that the sub-nasal and post-suborbital were connected in life by a lamina of cartilage. In *Dinichthys terrelli* this cartilage must have extended, vertically inclined, mesial to the ventrolateral borders of the marginal plate, posteriorly, and to have occupied, horizontally inclined, the prominent groove on the mesial surface of the "handle" portion of the suborbital element, anteriorly. In this forward part it would then have served as a strengthening support dorsolaterally for the supra-gnathal elements which dorsomesially were embedded in the cartilaginous braincase floor. From these homologies it may be postulated that the adductor muscles, originating on the ventrolaterally expanded marginal plate, passed downward toward their insertion on the inferognathals, mesial to the suborbital check plate and lateral or structurally dorsal to the restored palatoquadrate cartilage. The lengths of the posterior blade portions of both the suborbital and inferognathal plates as well as the length of the lateral margin of the cranial shield from post-orbital process to postmarginal tip may thus be considered indices of the length of the space occupied by the adductor muscles, as well as of the relative mechanical efficiency of the lever-like jaws. Some approximation to the cross-sectional area of these muscles may be approached through the projection of the ventrolateral expansion of the marginal bone, from which

the muscles originate, in reconstructed specimens where all elements are oriented in correct relationship to one another.

The distinctive modifications of *Gorgonichthys clarki* may be demonstrated by an application of the above considerations. For purposes of comparison the reconstructed heads of *Dinichthys terrelli*, *Gorgonichthys clarki*, and *Heintzichthys gouldii*, all reduced to a unit size, are shown in figure 4.

In *Dinichthys terrelli* it may be noted that the orbit is small. Its length is contained five and one-half times in the greatest lateral length of the cranial shield from the plane of the rostral tip to the hindermost limit of the postmarginal plate. The marginal length of the shield from post-orbital process to postmarginal extremity is thus the longest such dimension attained by any of the Ohio Shale arthrodires. This great length is reflected in the lengths of the posterior blade portions of both its suborbital and inferognathal elements. Similarly the ventrolateral expansion of the marginal plate is proportionately tremendous. The restored cross-sectional area of the adductor muscles was in consequence large and indicative of massive muscles. The fiber length was also relatively longer. This fact is shown by the more feeble extension of the posterolateral wings of the cranial shield, the depth of the vertically expanded blade part of the suborbital, and the degree of upward arching of the posterior blade portion of the inferognathal plate. The jaw mechanism must therefore be considered as both powerful and fast, and the *terrelli* group, with their acute cutting-edged mouth parts, consequently appear to have been the most formidable of the upper Devonian predators.

In contrast, the orbits of both *Gorgonichthys clarki* and *Heintzichthys gouldii* are much enlarged. Their lengths are contained two and one-half times and twice, respectively, in the greatest lateral length of the cranial shield. The marginal length, therefore, from which the adductor muscles originate is much reduced. The ventrolateral expansion of the marginal is correspondingly small. The restored cross-sectional area indicates much smaller

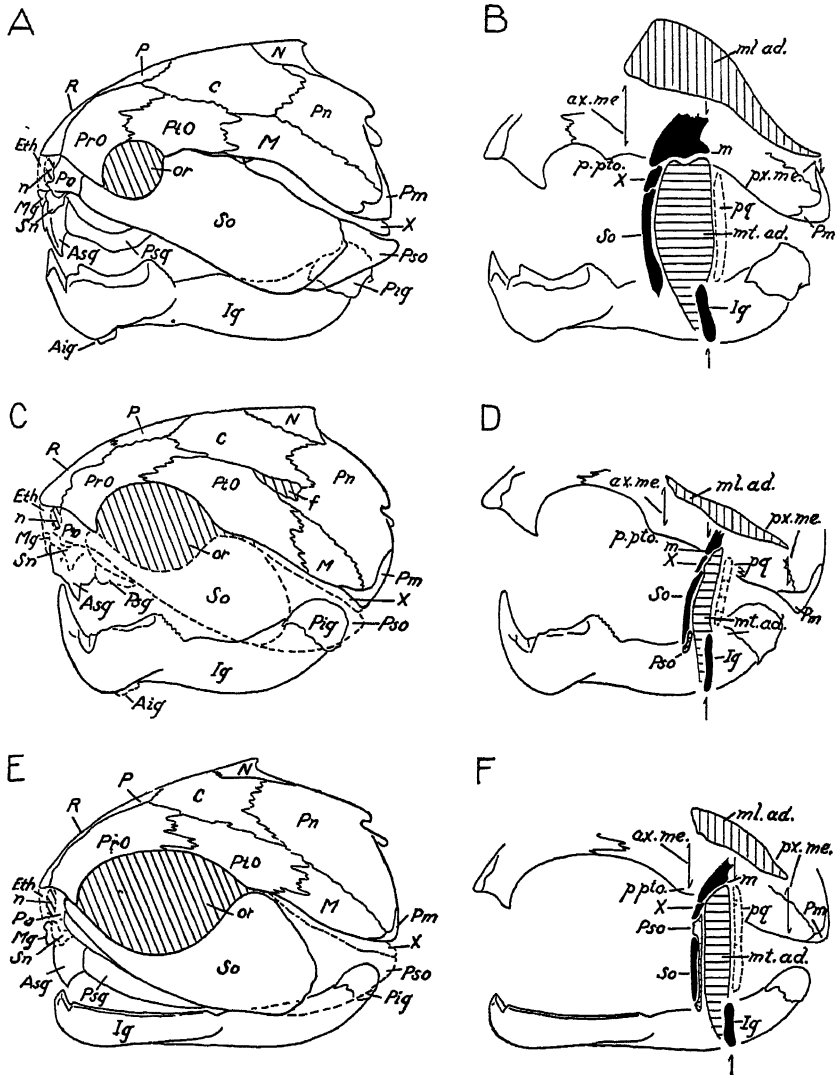


Fig. 4. Attempted restorations of the heads and of transverse sections through the cheek regions of (A and B, respectively) *Dinichthys terrelli*, (C and D, respectively) *Gorgonichthys clarki*, and (E and F, respectively) *Heintzichthys gouldii* to show the degree of variation in the proportions of homologous parts. In B, D, and F presumed dermal bone is indicated by solid black, cartilage and primary ossifications by stipples, and muscle sections by hachuring. Figures are all reduced to a unit size: that of *Dinichthys* being approximately $\times 1/14$; *Gorgonichthys*, $\times 1/12$; and *Heintzichthys*, $\times 1/6$, of average-sized specimens. Aig, antero-inferognathal plate; Asg, antero-supragnathal plate; ax. me., anterior limit of the ventrolateral expansion of the marginal plate; C, central; Eth, restored extremity of the ethmoidal cartilage; Ig, inferognathal; M, marginal; m, expanded ventrolateral edge of the marginal plate; Mg, mediognathal; ml. ad., frontal section through the restored adductor muscles; mt. ad., transverse section through the restored adductor muscles; N, nuchal plate; n, external nare; or, orbit; P, pineal plate; Pig, postero-inferognathal; Pm, postmarginal; Pn, paranuchal; Po, postnasal; p. pto., postorbital process; pq, restored palatoquadrate cartilage; PrO, pre-orbital; Psg, postero-supragnathal; Pso, post-suborbital; PtO, postorbital; px. me., posterior limit of the ventrolateral expansion of the marginal plate; R, rostral; Sn, sub-nasal plate; So, suborbital plate; and X, sub-marginal plate.

muscles than those possessed by the *terrelli* group. Shorter fiber length is also indicated by the greater extension of the posterolateral wings of the cranial shield and low suborbital blades in both genera. Interestingly, the decrease in mechanical efficiency of the jaw mechanism and these apparent losses in both power and speed of the muscles were, however, compensated for in two distinct adaptations. *Heintzichthys*, on the one hand, with relatively larger muscles than *Gorgonichthys*, reduced the anterior cusp of the inferognathal and the proportionate size of the antero-supragnathal. In return, the functional

lengths of its postero-supragnathal and opposing oral margin of the inferognathal were increased. *Gorgonichthys*, on the other hand, with proportionately the smallest muscles of the three genera discussed, reduced the length of the inferognathal part functionally opposed to the postero-supragnathal and increased both the size of the antero-supragnathal and the height of the inferognathal anterior cusp. This modification in attempting to concentrate all of the available force of weak muscles into one magnified point made *Gorgonichthys* a veritable "saber-toothed" arthrodire.

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THE GENUS *QUICHUANA* KNAB

By FRANK MONTGOMERY HULL¹

This genus contains a small number of characteristic and yet vaguely defined syrphids from the Neotropical region. The genus was originally erected by its author for two species. However, at least five other syrphids of older authors, described in other genera, have in recent years been reassigned to the genus *Quichuana*. In addition, I find that *Lepidomyia cincta* Bigot, previously placed in *Cheilosia*, may be added to *Quichuana* upon the basis of an examination which I made of the type while visiting the British Museum.

I wish to thank Dr. C. H. Curran who lent the American Museum collection and Dr. C. L. Fluke, who lent his own material in this genus to me for examination. I have studied and carefully drawn the types of most of the described species. The adults appear to be not uncommon, and Knab noted that the larvae live in water collected by *Bromelia* plants and possibly other epiphytes in the tropics, a habit not dissimilar to that of *Nepenthosyrphus* de Meijere (Java), the larvae of which inhabit the pitcher plants of *Nepenthes*.

THE CHARACTERISTICS OF THE GENUS *QUICHUANA*

Quichuana KNAB, 1913, *Insecutor inscitiae menstruus*, vol. 1, p. 1.

Small to medium sized, rather pilose and elongate flies, with pilose, holoptic eyes, the pile of head and eyes tending somewhat towards scaliform. The face is weakly tuberculate in both sexes and ornamented to some extent with characteristic arrangements of pile and pubescence. The antennae are elongate to a varying degree. The abdomen is slender in most species with nearly parallel sides that gently taper to the apex. The legs are relatively simple, with the hind femora moderately thickened. The venation of the wings is similar to *Helophilus*; the kink in the third vein is not unusually deep; the marginal cell is open; the anterior border of the wing is usually dark brown.

GENOTYPE: *Quichuana sylvicola* Knab.

The genus *Quichuana* appears to be most closely related to *Myiatropa* Rondani, a European genus, and to *Helophilus*. From both of these it differs in having elongate antennae, and from *Helophilus* in having

holoptic and pilose eyes in the male. Knab points out that it further differs from *Myiatropa* in having thickened hind femora and arcuate tibiae. The pilose eyes seem to be the principal difference separating it from *Habromyia* Williston. Nevertheless, the species of *Habromyia* are larger, rather bare, and often brightly marked, whereas *Quichuana* is without exception relatively pilose and dull colored. The pile in some species approaches the yellow, opaque, scalose, or flattened tomentum of *Meromacrus*, in which the eyes are bare and the marginal cell closed, but in *Quichuana* the pile is usually sericeous. In the past the flies of this genus have been confused with *Mallota*, *Helophilus*, *Platynochaetus*, *Xylota*, and *Cheilosia*. While the identity of the species in this genus is established with considerable difficulty because of the near resemblances of many forms, close study indicates that there are not a few characters which are available for separating one species from another. Further investigations of the pattern of the thorax, degree of incrassation of the fem-

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ora, their surface and pile, and the shape of the antennae should be helpful.

Because of certain differences in the sexes, I present a key to each sex as far as material is available. As the key was prepared after my return from the British Museum, I have been unable to key *cincta* and *subcostalis*. I have not seen *parisii*, *rieseli*, or the recently described *borgmeieri*.

TABLE OF SPECIES OF THE MALES OF *Quichuana*

1. Wings with a white spot at apex, the brown border diffuse, the frontal pile long and golden, the ground color not obscured (Panama).....
.....*calathea* Shannon
No such spot on wings.....2
2. Front with a dense mat of long, anteriorly directed, golden or brassy pile, quite obscuring the ground color (Peru, Brazil, Colombia).....
.....*auratus* Walker
Pile yellow, golden, or blackish, never sufficiently thick and matted to mask the ground color completely.....3
3. Face and front shining black; scutellum obscurely yellowish with yellow pile; abdomen largely shining metallic bronze (Mexico).....
.....*championi* Williston
Face largely pubescent with one or more bare stripes.....4
4. Face with only the median stripe...5
Face with the median, and, on either side, a lateral stripe that may be wide or narrow.....6
5. Legs, including the whole of the hind femora and tibiae, black (Brazil)....
.....*bezzii* Ceresa
Hind tibiae and tarsi dark brown; pile of the apices of hind tibiae black; frontal pile long, appressed, golden, not obscuring the ground color; hind metatarsal pile black (Colombia)....*quixotea*, new species
6. Front with entirely long, golden pile; hind basitarsal segment light brownish orange and golden pilose; apices of hind tibiae golden pilose; lateral face stripes broad but isolated (Bolivia).....*dolorosa*, new species
Front in part black pilose or wholly

- black pilose; pile of hind basitarsal segment black or yellow.....7
7. Facial side stripes less extensive, leaving well-developed areas of pubescence; scutellum dark brown, heavily pilose; hind tibiae at least brown in the center.....8
Bare side stripes of face large, almost obliterating the pubescence on the sides of the face, leaving a thin band anteriorly and along the anterior cheek margin; scutellum dark brown, reddish at apex, its pile quite sparse; hind tibiae and tarsi light brownish red throughout, the pile of their basitarsi in large part yellowish; antennae wholly jet black (Peru, Colombia).....9
8. Antennal base quite prominent; lateral stripes of face short and relatively broad; face itself short below and somewhat rounded; more robust species (Brazil)....*pogonosa* Fluke
Antennal base not conspicuously produced; lateral facial stripes long and slender, reaching much higher than the middle one; face more produced at epistoma, subrectangular; more slender species (Costa Rica).....
.....*picadoi* Knab
9. Second antennal segment fully twice as long as the first; third antennal segment twice as long as the second; abdomen of male narrower at base than apically (Peru)..*inca* Shannon
Second antennal segment about one and one-half times as long as the first; third antennal segment about one and one-half times as long as the second; abdomen of male wider at base than apically (Colombia).....*inca brevicera*, new variety

TABLE OF SPECIES OF THE FEMALES OF *Quichuana*

1. Face in profile produced deeply and rather sharply downward; dark pattern of wing filling out the whole of first basal cell and the entire end of the submarginal cell but not extending below it or its loop (Mexico).....
.....*niger* Giglio-Tos
Face short, never subconically pointed;

- the brown of the wings usually dilute at the apex of the submarginal cell, or extending below and beyond this, the apex of the wing occasionally with a white spot. 2
2. Face with only a medial bare stripe; face otherwise pubescent. 3
Face with a medial bare stripe and, in addition, either with a well-differentiated lateral bare stripe in the pubescence or, more rarely, with the lateral bare areas restricted to an elongate, bare patch on the upper side of the face near the antennae. 6
3. Antennae relatively short, the third segment about one and one-half times as long as wide. 4
Antennae elongate, the third segment a little more than twice as long as wide, brown in color, the first two segments lighter; medial facial stripe wide, stopping some distance from the antennae but reaching the epistoma; basal halves of abdominal segments 3 and 4, or all but the postmargin, erect and short yellow pilose, the posterior halves or less of these segments appressed black bristly. Wing apex sometimes with a white spot. 5
4. Midfacial stripe conspicuous, but not reaching the antennae or epistoma; the brown of the wing fills out only the end of the submarginal cell; face short, but produced a little downward, with small tubercle on the lower part; eyes heavily pilose (Brazil). *parisii* Ceresa
Midfacial stripe almost wanting, at least not conspicuous; face produced farther forward, less below, concave and without tubercle; eyes lightly pilose (Brazil). *bezzii* Ceresa
5. Pile of front abundant upon the anterior half of the front before the antennae and chiefly blackish, or at least dark brown, and almost matted. Face retreating, the antennal prominence of the front produced (Panama). *calathea* Shannon
Pile of lower front quite sparse and entirely golden; face less retreating (Colombia). *quixotea*, new species
6. First abdominal segment with conspicuous, laterally directed tufts of long whitish or golden appressed pile on either side. 7
This segment with at most a few long hairs near the extreme lateral margins, the middle of the first segment with microscopically short, appressed, whitish hairs or pubescence and without conspicuous tufts (Costa Rica). *picadoi* Knab
7. Fourth and usually the third abdominal segments wholly yellow pilose, erect or appressed. 8
These in part black pilose at least posteriorly, sometimes widely so. . . . 10
8. Hind tarsi, tibiae, and apical third and sometimes the base of the hind femora light red. 9
Hind femora except extreme apex black; their tibiae brownish black apically, with yellow pile, dark red basally; lateral facial stripes quite wide, especially below (Peru). *simonetta*, new species
9. Base of hind femora light reddish; lateral facial stripe narrow; third and fourth abdominal segments chiefly erect, yellow pilose, the pile becoming appressed near the posterior border, and typically with only five or six apical black hairs; fifth abdominal segment sparse, long, erect, typically black pilose, with two or three yellow hairs on apical margin, occasionally all its pile yellow (Bolivia). *knabi* Shannon
This base black; lateral facial stripe quite wide, the cheek-face band of pubescence very narrow; brown of wing sharply marked; the pile of hind basal tarsal segments wholly yellow (Peru, Colombia). *inca* Shannon
10. Abdomen quite broad and robust; brown of wing not filling any of the apical posterior half of the first basal cell. 11
Abdomen of the usual slender, tapering type. 12
11. Pile of scutellum long, appressed,

dense; mesonotum not conspicuously vittate, though vittae are present obscurely; second abdominal segment wholly yellow pilose; hind tibiae chiefly black pilose on inner as well as on outer face (Venezuela)... *cestus*, new species
Pile of scutellum sparse and erect; mesonotum with the usual four gray vittae, the lateral ones less pronounced; second segment of abdomen narrowly black pilose behind; hind tibia chiefly yellow pilose (Brazil)... *pogonosa* Fluke

12. The base of the wing and the anterior margin including the costa deep sepia brown; brown wing border dilute shortly beyond small cross vein (Panama)... *sepiapennis* Hull
The anterior wing margin, and especially the costa, dilute brown... 13

13. The front black and rather appressed pilose anteriorly, then erect, golden pilose, and finally erect, black pilose about the ocelli; lateral facial stripe confined to the upper half of face; brown of wings dilute, the costal cell dark (Amazon).....
..... *auratus* Walker

The front is sparsely pilose, black or yellow, the pile largely or wholly erect; the costal cell pale..... 14

14. Abdominal segments 3 and 4 yellow pilose on the basal three-fourths or more, black posteriorly; fifth abdominal segment wholly sparse, long black pilose; third antennal segment one and one-half times as long as the second; pile of the front almost wholly yellow; hind femora narrowly red distally; hind tibiae unusually arcuate (Costa Rica)....

..... *picadoi* Knab

Abdominal segments 3 and 4 very narrowly yellow pilose basally; fifth abdominal segment appressed black pilose; third antennal segment twice as long as the second or nearly so; front with sparse, long, black pile throughout the middle; hind femora with a small, elongate, apical, reddish spot (Peru).....

..... *sylicola* Knab

Quichuana cestus, new species

Figures 4, 14, and 16

FEMALE

Abdomen quite broad basally, and with flattened, laterally directed tufts of brassy yellow pile on the first segment; most of the abdomen with brownish gold pollen. Length, 11 mm. Related distantly to *auratus* Walker.

HEAD: The vertex is shining black with thick black pile in front and behind; the occipital pile, however, is bright, brassy golden with some long black hairs inside the golden ones along the upper eye margin. The front is shining black with black pile throughout the center, rather long, thick, and erect but with a narrow band of golden pile along each eye margin that also contains golden pubescence; a few of these hairs are erect, but more of them are appressed. The eyes are thick, highly shining whitish pilose, more yellowish pilose dorsally. The antennae are black, the first two segments jet-black and shining with black pile; third segment large, about one and one-half times as long as wide, broadly rounded apically; arista light red throughout. The face is shining black with yellowish white pubescence as shown in figure 14. The face is covered with extensive, long, shining, sulphur yellow or brassy pile except upon the bare middle stripe.

THORAX: Mesonotum dully shining black, overlaid with dark, olive brown pollen; throughout the center, a pair of wide, almost contiguous, light, olive brown pollinose vittae, which are evanescent before the scutellum. The humeri are shining black with a patch of brownish yellow pollen medially. The pile of the mesonotum is very thick and dense, appressed, rather long and entirely brassy yellow. There is a thicker, longer tuft of bright pile on the notopleura and another on the extreme upper part of the mesopleura, which is continued more sparsely down the mesopleura. The scutellum is concolorous, with similar but longer and posteriorly directed pile. The squamae are brown, dark brown on the posterior half, with light brown fringe.

LEGS: Black; the hind femora are moderately thickened and have yellow pile except on the lateral and dorsal portions distally, where the pile is black. The ventral, distal pile consists of both short and long black bristles and along the ventral margin laterally there are seven or eight very long, slender, golden hairs. The pile of the hind tibiae is chiefly golden dorsally and laterally but black along the ventral margin; the hind tarsi are very dark brown.

WINGS: With brown anterior margin, the loop of the submarginal cell entirely clear. The small cross vein is margined with brown, the marginal cell very widely opened.

ABDOMEN: Quite broad, relatively short, and pointed apically; it is at least as wide as the thorax and is everywhere dully shining brownish black. The first segment has outwardly directed, long yellow pile in the posterior corner, and on the posterior margin toward the middle there is a transverse, thick, appressed tuft of long, outwardly directed, bright, brassy yellow pile. The pile of the second segment is entirely bright brassy, very thick and suberect. The pile of the third segment is similarly colored on the basal half and whole lateral margins but is appressed black posteriorly. The pile of the fourth segment is similar to that of the third, the golden basal pile a little less extensive, the black posterior pile more suberect. The pile of the fifth segment is almost wholly black, with a few yellow hairs along the base.

TYPE: Holotype, female, Mt. Duida, Venezuela, January 11, 1929. In the American Museum of Natural History.

***Quichuana simonetta*, new species**

Figures 3 and 7

FEMALE

Antennae unusually large, and the third segment elongate; abdomen broad but oval and wide, also apically; abdomen short pilose, the pile wholly pale and appressed. Length, 11 mm. Related to *knabi* Shannon.

HEAD: The occiput and the vertex and front are shining black; the upper part of

the front is obscured by light yellowish or brownish white pollen; the pile of the front is erect, long, rather sparse, and yellowish white. There is some black pile in front of the ocelli and there are a few long hairs behind, but the occipital pile is yellowish white. The front is very prominent and the antennal base protrudes quite strongly. The facial profile is shown in figure 3. The face and cheeks are shining black, thinly covered with grayish yellow pubescence which leaves a middle stripe attenuated above, and a wider lateral stripe bare and shining as shown in figure 3. The pile of the face is long, sparse, shaggy, and pale yellow. The antennae are quite long and large, the third segment is nearly two and a half times as long as wide, and all the segments are black; the medial pile of the second segment is brassy, the lateral pile black; the arista is thickened and light reddish brown.

THORAX: Moderately shining black with abundant, subappressed, golden pile and a transverse band of black pile between the wings; the anterior part of the posterior calli has black short pile. The scutellum is dark reddish brown to black, with brassy yellow pile that is fairly sparse.

LEGS: Femora shining black, the hind pair moderately thickened, their apex narrowly reddish, their pile entirely light yellow including the apex but excepting a patch of short, black, ventral spinules upon the distal third. On the outer surface of this patch there are several long black bristles. The hind tibiae are dark reddish brown on the basal half, almost black apically; their pile everywhere whitish except for a few black hairs on the ventral surface just past the middle. The hind basitarsi are light reddish brown with chiefly yellowish white pile and a few black hairs above and a few more upon the anterior margin. The remaining segments are dark brown. The anterior and middle tibiae are chiefly black, the bases of the mid-tibiae are reddish, their tarsi dark brown, their pile is whitish.

WINGS: Nearly hyaline with a very dark brown border terminating at the end of the submarginal cell; the costal cell, however, is very pale brown, almost hyaline. In

the first basal cell, the brown border fills out only that part of the area lying above the vena spuria which is proximal to the nodal spot, and of that area above the vena spuria which comprises the distal section of this cell the brown color fills out only the upper half. The upper basal corner of the first posterior cell is brown, the loop of the submarginal cell is entirely clear.

ABDOMEN: Broader than is usual in the genus, but the sides of the first three segments are nearly parallel and only a little narrower apically. There is, on the posterior margin of the first segment, on either side of the midline, a tuft of sparse golden hairs, appressed and directed outwardly.

TYPES: Holotype, female, and two paratypes, females, Huanoabama, Peru, 1500 meters.

The type and one of the paratypes were returned to the Naturhistorisches Museum in Vienna; one paratype is in the author's collection.

Quichuana dolorosa, new species

MALE

Characterized by wholly golden pile of the front, the ground color not obscured, and also by the light brownish orange hind basitarsi, which are golden pilose. Length, 9.5 mm. Related to *auratus* Walker.

HEAD: The vertex is shining black; there is a tiny triangle of pale yellow pubescence anteriorly upon the vertical triangle; the eyes touch for a distance equal to two to three times the length of the anterior ocellus; the occipital pile is golden and there is a tuft of long black hair between the ocelli; the front is shining black with only thick, long, forwardly thrust, golden pile which, while quite abundant, in no wise obscures the ground color. The face and cheeks are shining black with three bare black stripes; the lateral ones are a little wider than the median one and entirely enclosed by the pale yellowish white pubescence. The pile of the face is abundant, long, and golden. The antennae are elongate, the third segment twice as long as wide and light grayish brown, the base is orange brown, the arista more slender and pale orange throughout;

the first two antennal segments are black with golden pile on the inside and a few black hairs dorsally. The eyes have thick brown pile above, but sparse, glistening, whitish yellow, scale-like pile over the lower three-fourths of the eyes.

THORAX: The mesonotum is dull, dark, olive brown or greenish gray with a single, opaque, black, anteriorly slender, medial vitta that becomes a little wider throughout the length of the dorsum. There is a similar, wider, though slightly less distinct vitta on either side upon the lateral portion of the mesonotum. It is divided at the transverse suture, and both sections are pointed at their opposite ends. The pile of the mesonotum is exceedingly thick, fairly long, nearly erect, and bright golden. It is almost matted, and there is a matted tuft of more opaque pile upon the notopleura, continuing down upon the upper part of the mesopleura. The very dark brown, feebly shining scutellum is similarly colored with long, very thick, shining brassy pile.

LEGS: All the femora are black, the hind femora moderately thickened, with thick golden pile above and a number of short black hairs at the extreme apex, and a ventral patch of stout, black, spinous bristles on the ventral distal third. There are a few longer bristles on the side of this patch. The hind tibiae are blackish in the middle but light brownish red on the basal third and upon the apex. The pile is everywhere golden except for a short row of black hairs beyond the middle upon the ventral surface. The first two to three hind tarsal segments are pale orange brown, the last two darker. The pile of the basitarsi, except for six slender black hairs, is entirely golden. The anterior legs are very similar to the hind pair, their tibiae dark brown in the middle, their femora without the black spinous bristles.

WINGS: Nearly hyaline without the brown anterior border, even the stigmal cell is hyaline, the stigmal cross vein brownish.

ABDOMEN: Broader than usual but tapering; the abdomen is short and completely covered with rather long, erect, exceedingly dense yellow pile. The hairs are

appressed on the extreme margin of the fourth segment. On either side of the first segment posteriorly there is a tuft of appressed, outwardly directed, golden pile.

TYPE: Holotype, male, from Mapiri, Bolivia, February 20, 1903 (Sarampioni), 700 meters. In the American Museum of Natural History.

Quichuana inca Shannon

Figures 11, 18, and 24

Quichuana inca SHANNON, 1925, Proc. Ent. Soc. Washington, vol. 27, p. 111.

The species *inca* is notable for the very long second antennal segment, the unusually dense, matted tuft of short, brassy yellow pile upon the apex of the first abdominal segment, with its hairs directed outward, and also for the pile of the eyes, which though sparse is more silvery and more flattened than is common. In the male the ocular fringe of short yellow pile along the sides of the front should be noted. From Huascaray, Peru.

Quichuana inca brevicera, new variety

Several specimens differ from *inca* Shannon in having much shorter segments of the antennae and an abdomen of different shape.

The second antennal segment is not over one and one-half times as long as the first, and the third segment is in the same proportion to the second. Also in the males the base of the abdomen is wider than is the apical half, whereas the type of *inca* is narrower at the base than apically. The specimens upon which this variety is based are two males from the British Museum from the Atrata Valley, Boca de Arquia, Colombia (v-vi 1914). I have also seen specimens from Bogota. The species *inca* is one in which the brown anterior border of the wing is deep and quite distinct with relatively sharp posterior margin to the brown color. Types of this variety are in the British Museum (Natural History).

Quichuana subcostalis Walker

Figures 20 and 28

Xylota subcostalis WALKER, 1860, Trans. Ent. Soc. London, new ser., vol. 5, p. 291.

The type, a female, was examined at the British Museum and its face illustrated. There is a complete white pollinose band across the front, and the frontal pile is sparse. The antennae are pale brown; the pubescence towards the apex of the third antennal segment is noticeably longer. The abdominal pile is as follows: pile upon the whole of the second segment, the basal half of the third, and nearly all of the basal half of the fourth erect. The erect basal pile is all yellow, but the erect or nearly erect pile on the posterior part of the second segment is black. The appressed pile of the third and fourth segments is black, and all pile black on the fifth segment. This fifth segment pile is longer and bristly but very delicate. There is a band of appressed yellow pile on the first segment. The hind femora are very dark, shining red, brighter at the tip. The brief description of Walker is as follows:

"Female. Black, shining; head with cinereous tomentum on each side in front; antennae seated on a tubercle; third joint elongate-conical, as long as the first and second together; thorax with four cinereous stripes, and on each side with slightly gilded hairs; pectus cinereous; abdomen lanceolate; knees ferruginous; hind femora thick; hind tibiae curved; wings grayish; with a black stripe which is sub-costal for full half the length, and costal from thence nearly to the tip; veins black; halteres whitish. Length of body 5 lines; of wings 8 lines. Mexico."

Quichuana sepiapennis Hull

Figures 1 and 5

Quichuana sepiapennis HULL, 1943, Rev. de Ent., Sao Paulo, Brazil, vol. 14, p. 510.

This species is distinguished by the deep sepia border of the wing, which shortly beyond the small cross vein becomes quite dilute and rather faint, as well as more narrowly restricted to the immediate margin. The species was described from Panama.

Quichuana pogonosa Fluke

Figure 8

Quichuana pogonosa FLUKE, 1937, Amer. Mus. Novitates, no. 941, p. 11.

The types of this species were kindly lent by Dr. Fluke. It is a very robust fly, somewhat related to *cestus*, new species. The distinctions given in the key will serve to separate the one from the other. Also before me are specimens from Rio Grande do Sul. The species was described from Nova Teutonia, Brazil.

Quichuana calathea Shannon

Figure 13

Quichuana calathea SHANNON, 1925, Proc. Ent. Soc. Washington, vol. 27, p. 111.

Because of the characteristic white opaque spot at the tip of the wing of the male, this species is quite distinct in this sex. The females are more difficult to distinguish and are easily confused with the females of *auratus* Walker and of *picadoi* Knab. Shannon states that the white wing spot sometimes occurs in the female, but I have seen no females with it, nor have I seen any males without it. My study of this species has been based upon the type and upon a crumpled paratype given me in 1925 by R. C. Shannon, in which, however, the head is in good condition though teneral. In this specimen the abundant pile of the lower front is dark brown and would certainly have been black in the fully developed adult stage. I have studied a series from Muzo and Restrepo, Colombia, and I have a male presented to me by Dr. Gunther Enderlein. It is from Cordillera V., Colombia, *tierra caliente*. In *calathea* the lateral bare stripes of the face are characteristically wholly absent. The species was described from specimens "reared from the water and material in the flower bracts of a large species of *Calathea*" at Porto Bello, Panama.

Quichuana knabi Shannon

Figures 9, 15, and 22

Quichuana knabi SHANNON, 1927, Proc. U. S. Natl. Mus., vol. 70, p. 15.

In this slender Bolivian species the pile upon the second abdominal segment is not in the least sparse. The abdominal pile, except upon the fifth segment, is almost entirely yellow and, except near the posterior margins of the segments, it is almost

wholly erect. In this respect the species is much in contrast to *inca* Shannon and *simonetta*, new species, in which the pile is largely or wholly flat appressed. The pile of the fifth abdominal segment is typically black but may be yellow.

Quichuana sylvicola Knab

Figures 10 and 23

Quichuana sylvicola KNAB, 1913, Insector inscitiae menstruus, vol. 1, p. 14.

The abdominal pile of this species alternates from black to yellow, a condition common to several species. The following notes are based on the type. Upon the second segment the pile is about evenly divided, yellow and erect on the basal half, black and appressed on the apical half; on the third segment there is black appressed pile on at least the posterior two-thirds, the anterior pile being erect and yellow; and upon the fourth segment only one-fourth to one-third of the pile is yellow and erect, the posterior pile being black and appressed. The pile of the fifth segment is entirely black. Turning to the head, the pile of the front is long but sparse; it is golden yellow on the outside but there are 12 to 15 long black hairs up and down the middle of the front. The hind femora are almost wholly shining black, with elongate reddish spot at the apex. From Peru.

Quichuana picadoi Knab

Figures 12, 17, and 25

Quichuana picadoi KNAB, 1913, Insector inscitiae menstruus, vol. 1, p. 14.

The following notes regarding this species are based on the type. The pile of the abdomen is erect except on the posterior fourth of the third and fourth segments, where it is flat-lying and black; the anterior pile is yellow. The sparse long pile of the fifth segment is entirely black. The base of the first segment has a thick, outwardly directed tuft of flat-lying, yellow pile. The front of the head has only yellow hair with the exception of a few black hairs at the apex and sides just above the antennae; the pile is rather abundant but not dense. The infuscation of the wings is characteristically very poor and weak; it is of a different pattern from *sylvicola*.

This species was described from Costa Rica. I have seen additional specimens from there, and I have seen also specimens from Colombia that seem to belong here but in which the tufts of yellow pile upon the first abdominal segment are entirely lacking, notwithstanding the fact that the specimens are otherwise fully pilose. In place of these tufts there is only whitish pubescence; it is possible that these flies are denuded.

Quichuana championi Williston

Figures 19 and 27

Mallota championi WILLISTON, 1892, *Biology Centrali-Americana*, vol. 3, p. 69.

This is a robust species with oval abdomen which is wholly yellow pilose. The pile in the type is quite long and dense, especially long on the sides and upright on the second, third, and base of the fourth segments. The apical band of tufted pile upon the first segment is conspicuous, and the pile is partly directed forward and to the side and partly backward and to the side. The bright brassy bronze ground color of the abdomen is distinctive. The face is wholly bright shining black; there is a stripe of pubescence bordering the cheeks anteriorly. Williston was aware that his species did not properly fit into *Mallota*.

Quichuana cincta Bigot

Figures 21 and 26

Lepidomyia cincta BIGOT, 1883, *Ann. Soc. Ent. France*, ser. 6, vol. 3, p. 345 (Mexico).

Williston in his synopsis suggested that this species might be related to *Cheilosia*. The author studied the type in the British Museum and illustrated the face and found that the species should properly be transferred to *Quichuana*. The prominent front and the receding, downwardly produced, non-tuberculate face should be noted. The sides of the face diverge more than commonly while proceeding downward. The face is bare and without pubescence. Upon the abdomen the pile of the second segment is nearly erect and wholly yellow; on the third segment the nearly erect or only subappressed pile of the posterior fourth is black, the remainder yellow; on

the fourth segment all the pile is semi-appressed and is posteriorly black and anteriorly yellow, with more black than yellow. The yellow basal band of flat pile is present on the first segment. The hind femora are shining black with reddish tip; their tibiae brown and darker in the middle. The following is a translation of Bigot's brief description:

MALE

"Length, 8 mm. Black and a little shining and rather thinly yellowish pubescent; on the tibiae there are some black hairs.

"HEAD: Antennae of a deep chestnut brown, lighter brown at the base, upon the upper part and at the extremity; arista testaceous; face shining, with a sparse yellow pubescence. Eyes hairy.

"THORAX: With two longitudinal, grayish, rather obscure stripes; scutellum brown, shining, the extremity yellowish brown; squamae brown; halteres testaceous.

"LEGS: Bases of the tibiae and of the tarsi largely yellowish-brown.

"WINGS: Almost hyaline, the external border largely tinged with brown.

"ABDOMEN: First segment covered with yellowish hairs."

Quichuana bezzii Ceresa

Quichuana bezzii CERESA, 1934, *Atti Soc. Italiana Sci. Nat.*, vol. 73, p. 387, fig. 3.

FEMALE

"HEAD: Eyes hairy, the pile fine, silvery whitish. The ocellar triangle touching the eyes and with black pile. Front black and shining, with sparse, imprinted points and golden yellow pile, these last more dense along the orbit. Antennal tubercle prominent shining black, brownish below. Antennae inserted on the upper half of the head, longer than half of the face; bent a little elbow-like. First segment on the distal part, second upon the whole, with setaceous black pile, both obscure brown; third segment more clear, ferruginous, smooth and suboval. First short, second almost twice the first, third almost twice the second. Arista bare, ferruginous, slightly longer than the antenna. Face

black, with brownish gray pruinosity and sparse, yellowish pile excepting the facial callosity and two, shining stripes that go from the inferior margin of the eyes to the edge of the mouth. Occiput ciliate with pile of a golden yellow, which becomes white on the lower part; mixed in with these are some black hairs. Mouth opening wide. Proboscis brown.

"**THORAX:** Mesothorax black, with light, metallic reflection, semi-opaque and impressed, as also the scutellum, with a certain regularity and provided with short yellowish pile, with traces of two pruinose stripes which vanish posteriorly. The area adjacent to the humeral calli, including its base, is covered with grayish white pruinosity. Humeral calli and postalar calli dark brown. Mesopleura and pteropleura with yellowish hairs. Ventral part light whitish pruinose. Scutellum shining brownish with apical part more clear and with short black hair; margined with fringe of longer, clear, golden yellow hair. Halteres whitish. Squamae of the same color, with the edge slightly darker and fringe whitish.

"**LEGS:** Very dark brown, with somewhat long silvery white pile; apical part of the femora and the tibiae of the first and second pairs clearer and ferruginous. Tibiae of the third pair arcuate only in the last third. Posterior femora slightly enlarged, furnished in the last third of the lower margin with irregular, black spines, and with an impression in the depressed area. First four segments of the tarsi decreasing in length; fifth almost equal to the third, provided with black pubescence, which on the lower side is fulvous. Pulvilli yellow; claws yellow, the apical half black.

"**WINGS:** Non-hyaline, slightly infuscated and iridescent. Anterior part with a dark brown coloration extending from the base of the wing (with the exception of the first and almost all of the second costal cells, which are clear) as far as the end of the submarginal cell. In width this coloration extends from the anterior margin to all of the first basal cell and to the basal part of the subapical cell, thence to all the submarginal cell but not including the

sinuous part. Subcosta and marginal cells more clear at the apices. Spot of the cross vein present. Veins of a brown color.

"**ABDOMEN:** Of the width of the thorax, elongate, shining black, with a sparse punctation and light bluish reflection, covered with a short, sparse, downy pilosity of a yellowish white color. On the outer margin of the second and third tergites and on the sides of the first and second, the pile is longer and yellowish. First tergite opaque, velvety, and slightly restricted under the base. Venter black.

"Length, 10.5 to 12 mm.; of wing, 8 to 9.5 mm.

"From San Sebastiao, Brazil."

(Translation from original description.)

Quichuana parisii Ceresa

Quichuana parisii CERESA, 1934, Atti Soc. Italiana Sci. Nat., vol. 73, p. 389, fig. 4.

FEMALE

"**HEAD:** Entirely of a shining black color. Eyes hairy, the pubescence silvery white, longer and more thick than in the preceding species [*bezzii*]. Ocellar callosity with black pile. Ocelli equidistant, the distance between the two basal ones equal to that of each of these from the eyes. Front rather wide, slightly narrowed at the top, with minute silver white pile. Antennal tubercle not prominent. Antennae inserted in the upper half of the head, less long than the half of the face. First segment short, obscure brown, almost black, second a little longer, clear ferruginous; the first two segments with sparse, black, setate pile on the distal margin; third twice the length of the second, dark ferruginous with clear base, glabrous and oval. Arista bare, ferruginous, a little longer than the antenna. Pubescence of the face distinct and a silvery white. Median callosity and two stripes that extend from the inferior angle of the eyes to the edge of the mouth are bare. Occiput widely ciliate with white hair, between which are some sparse black hairs. In the inferior region, there is noticed a little ferruginous spot. Mouth opening wide. Proboscis black.

"**THORAX:** Mesothorax black with light bluish reflection, provided with whitish

yellowish pile, with wide and fine punctation. Pleura dark brown. A tuft of whitish pile on the mesopleura. Pile black on the pteropleura. Humeral calli and postalar calli dark brown. Scutellum shining, obscure, brown, with yellowish pile which is rather long. Halteres whitish. Squamae of a like color, with golden yellow fringe.

"LEGS: Dark brown, with yellowish white hairs. Apical part of the tibiae and tarsi below with fulvous pubescence. Third pair of legs with the tibiae arcuate and the femora but little enlarged, armed with little black spines on the last third of the lower margin and with a light impression in the depressed area. First segment of the tarsi twice as long as the second; third about equal to the fourth; fifth longer. Pulvilli yellowish. Claws yellow on the basal half, black on apical half.

"WINGS: Non-hyaline, slightly infuscated and iridescent. Anterior part, including the veins, yellow on the basal half and up to a little beyond the small cross vein, and about as far as the top of the lower cross vein; from that point on dark brown, as is also the venation, as far as the extremity of the submarginal cell excepting the sinuous part. Base of the first posterior cell also dark.

"ABDOMEN: (Second and third segments) a little wider than the thorax, suboval, shining black with slight greenish reflection and the same punctation as the thorax, the pubescence formed by silky yellowish white pile, a little longer at the side of the first and second tergites. At the posterior margin of the tergites the hairs are more robust and more yellow; in the central part these hairs are mixed with short black hairs. First tergite on the posterior part with light grayish pruinosity. Venter blackish and pilose.

"Length, 9.1 mm.; wing, 5.8 to 6.5 mm.

"From Sao Paulo, and San Sebastiao, Brazil."

(Translation from original description.)

Quichuana niger Giglio-Tos

Platynochaetus niger GIGLIO-TOS, 1892, Boll. Mus. Zool. Comp. R. Univ. Torino, vol. 7, no. 123, p. 6.

FEMALE

"HEAD: Face almost vertical and bare [*piana*], not distinctly carinate, but obtusely tuberculate in the middle, uniformly black, very shining, sparsely covered with long, sericeous, yellowish hair. Front fairly wide at the base, much narrower above, shining black and sparsely covered with fairly abundant, long, black pile. Fronto-antennal prominence well developed; brownish testaceous beneath. Antennae long and approximately the length of the face; first two joints brownish testaceous beneath, black along the upper margin; third joint oval-elongate, scarcely wider at the base, black. Arista fairly long and testaceous. Proportions of the joints of the antennae 1:1:2. Eyes pilose; among the long hairs, there are some shorter ones, which are silky yellowish.

"THORAX: Black, uniformly sprinkled over with fairly long and numerous, yellowish olivaceous hair. Lower part of thorax black, shining, with a few whitish hairs on the pleura. Scutellum ferruginous, opaque, with long, yellowish olive hairs on the margin.

"LEGS: Black, somewhat pilose, the apices of the femora, bases of the anterior and posterior tibiae, all of the middle tibiae, the first two joints of the middle and posterior tarsi and the last joint of the middle ones of a yellowish color. Claws yellow on the basal half, black on the apical half. Pulvilli yellow.

"WINGS: Clear, brown along the anterior margin; the brown coloration, beginning from the base, extends in length to the extremity of the submarginal cell, in width it extends from the anterior margin to part of the base of the second basal cell, to all of the first basal cell, projecting somewhat beyond the anterior cross vein, from there to all of the submarginal cell with the exception of the sinuous part; marginal cell open; third longitudinal vein strongly incurved toward the first posterior cell, but non-appendiculate; anterior cross vein slightly oblique and placed scarcely beyond the middle of the discal cell. Squamae nearly blackish. Halteres whitish.

"ABDOMEN: Flattened, subtriangular, truncate towards the apex, black, covered with a pubescence formed of sparse and short yellow olivaceous hair, longer at the side of the base of the second segment; on the posterior margin of the first segment, there is abundant sulphur yellow pile forming a transverse fascia which, however, does not reach the sides. Venter ferruginous.

"Length of body, 12-10 mm.; of the wing, 9-7 mm.

"From Orizaba, Mexico."

(Translation from author's description in "Ditteri del Messico," 1893, Mem. R. Accad. Sci. Torino, ser. 2, vol. 43, pp. 338-339, pt. 2, pl. 1, fig. 1, 1a.)

Quichuana rieseli Shannon

Quichuana rieseli SHANNON, 1927, Rev. Soc. Ent. Argentina, vol. 1, no. 3, p. 5.

"Of the same size and proportion as *Q. championi* (Williston), and with the following characteristics:

"HEAD: Smallest diameter of the front (in the region of the ocelli) almost equal to the length of the third joint of the antenna, gradually widening below, being at the base of the antenna equal to the length of the antenna; front amply covered with loose hairs, yellow in color, but black in the ocellar region; antennae obscurely brown, arista brown and nearly of the same length as the antenna and more or less equal to two-thirds of the width of the face. Face almost entirely covered with pollen of a clear color, and clothed with rather long and loose pile, eyes pilose.

"THORAX: Mesonotum obscurely bronzed with a pair of vittae near the middle which appear to be covered with clear pollen; mesonotum yellowish pilose; there is a transverse line interrupted by stiff black hair near the anterior border.

"LEGS: The femur is black, its tips yellow, the tibiae yellow on the basal half and darker on the outer half; tarsi brown, darker towards the apex; the posterior femur has long strong hairs on the ventral surface that are directed downward.

"WINGS: Veins on the outer half of the wing smoky; lower squamae pale yellow,

the external border blackened, its fringe pale yellow.

"ABDOMEN: Dark bronze-colored, the second segment with a large, opaque, triangular spot in the center the base of which abuts on the anterior margin of the tergite; the first tergite with thick pile of a yellow color; the rest of the abdomen is amply covered with short yellowish hair, mixed with some black hairs.

"Length, 10 mm.; wing, 8.5 mm.

"From Tucuman, Argentina (from a *Bromelia*)."

(Translation from original description.)

Quichuana angustiventris Macquart

Merodon angustiventris MACQUART, 1855, Dipteres exotiques nouveaux ou peu connus, suppl. 5, p. 90.

MALE

"Length, 3.5 lines.

"HEAD: Face has pubescence [duvet] of a whitish gray; there is a medial stripe of shining black. Front strongly projecting, with yellowish brown pile changing to white. Antennae black, almost as long as the face, directed to the front, a little pendent; second segment a little elongate, the third three times as long as the second, a little enlarged at the base; arista yellowish brown. Eyes with white pile.

"LEGS: Black, femora with yellow pile, the hind ones thickened, without tooth; a ridge below in the intermediate part of the length; tibiae testaceous at the base; the intermediate ones have yellow pubescence and pile; the posterior ones have yellow hairs anteriorly and black hairs posteriorly; tarsi testaceous.

"WINGS: Clear, anterior border brown; veins normal.

"THORAX AND ABDOMEN: Covered with a thick pile of a beautiful silky yellow, ventral part bare. Abdomen narrower than the thorax.

"Country unknown."

(Translation from original description.)

Quichuana auratus Walker

Figure 2

Helophilus auratus WALKER, 1857, Trans. Ent. Soc. London, new ser., vol. 4, p. 153.

The type of this species was examined by

the writer while visiting the British Museum. It is characterized in the male by the thick golden pile of the front, obscuring the ground color. According to Shannon, who apparently examined the type of *angustiventris* Macquart in the Musée Histoire Naturelle in Paris, this is also true of that species. If the two species are identical, the latter name would have priority. This question cannot be decided at the moment. I have what I believe to be *auratus* Walker from Colombia, and I have redescribed the species in detail from these specimens. The original description of Walker comprises only three lines of type and is not very helpful. Walker's description is as follows:

"MALE: Black, covered with gilded down, which is brightest on the vertex; abdomen aeneous; wings greyish, brown in front, veins black.

"Length of body 4 1/2 lines; of the wings 7 lines.

"Valley of the Amazon."

I have redescribed *auratus* below from males and females from Colombia and from middle Rio Ucayali, Peru.

MALE

Length, 9-11 mm.

HEAD: The eyes of the male touch more narrowly than in some species or may even be very narrowly separated. The pile of the vertex is black, that of the upper occiput exceedingly dense, sometimes pale yellow, but more often golden. The upper eye pile is very thick, brownish black above, sparse and silvery below. The front is hidden beneath a thick, bushy hood containing many layers of long, flat, bright golden brassy hairs which reach over the anterior end of the frontal prominence, almost as far as the end of the first antennal segment. The face is gently concave beneath the antennae and retreating. The face has a long, low elevation on the lower half, is bare in the midline, silvery gray pubescent on the sides, with a narrow, vertical, lateral, nearly bare stripe which reaches down only to the middle of the face. The antennae are brown, the second segment lighter; the third segment is blackish and considerably narrower on the

apical third than on the basal two-thirds and longer than the first two segments combined; the arista is pale brown.

THORAX: Mesonotum dully shining, olivaceous black, with a pair of narrow, obscure, grayish vittae in the middle and none laterally. The mesonotum is covered with exceedingly dense, rather long, suberect, golden brassy pile that continues onto the shining blackish scutellum. Upon the notopleura, however, and upon the mesopleura and pteropleura this pile is replaced by opaque tomentum.

LEGS: Femora dark brown with brassy pile; long and bristly below upon the hind femora but short and black upon the apical fifth. Tibiae light brown, almost yellowish upon the middle tibiae and base of anterior and hind pairs. The apex of the hind tibiae is darker, with black pile except medially and ventrally. The tarsi are all dark brown, the middle tarsi somewhat lighter. The pile of the hind metatarsi black.

WINGS: With light brown anterior border, the costa less dark, but darker than the posterior part of the wing.

ABDOMEN: Of the slender type, a little wider basally, shining olivaceous black; the basal margin of the first segment is opaque black, expanding almost suddenly into a medial, opaque vitta that does not reach the posterior margin. There are smaller, obscure, medial, subopaque vittae in the middle of the third and fourth segments. Pile of abdomen unusually long and very dense, erect and yellow and only slightly shiny. There is a band of erect black pile on the posterior margin of the fourth segment, and in the center a single row of black hairs on the posterior margin of the third segment. Hypopygium shining black, its pile black.

FEMALE

HEAD: Similar to that of the male; the pile of the front is erect and golden but is black about the ocelli and upon the lower half of the shining black front. The pollinose area of the front consists of a pair of diagonal, slightly arcuate connecting stripes.

THORAX: Lateral stripes of mesonotum

scarcely evident, the scutellum almost black, the pile of the mesonotum quite scant, short and erect, but golden with the usual opaque tomentum on pleura and posterior calli.

LEGS: Similar to those of the male; femora varying from dark reddish brown to shining black.

WINGS: Similar to those of the male.

ABDOMEN: The medial, opaque black stripe of the second segment is reduced to a triangle and still further reduced on the remaining segments. Yellow erect pile of the abdomen scant and sparse, the bands of black pile upon the posterior borders quite narrow and the pile sparse.

Quichuana quixotea, new species

Figure 6

Related to *auratus* Walker, and readily distinguished in the male by the bright golden pile of the front, which, however, unlike that of the male of *auratus*, is not sufficiently matted and tufted to form the dense, forward lying hood that lies over the front of that species. In the female,

quixotea is distinguished by the small amount of black pile in front of the ocelli, the less prominent fronto-antennal region, the longer and more abundant black pile in front of the antennae, the longer second antennal segment, and the subtriangular spots of pollen upon the front. Length, 11 mm. From Colombia.

Quichuana borgmeieri Lane and Carrera

Quichuana borgmeieri LANE AND CARRERA, 1944, Rev. de Ent., vol. 15, pp. 205-208.

This species was published just as the present study was completed. Described from Sao Paulo, Brazil, it has not been seen by the author. It was stated to have been reared from larvae found in pools upon the nodes of bamboo.

Habromyia barbiellinii Ceresa

Quichuana barbiellinii CERESA, 1934, Atti Soc. Italiana Sci. Nat., vol. 73, p. 383, figs. 1-2.

The bare eyes relegate this species to the genus *Habromyia*. The facies is not unlike that of some species of *Meromacrus*. Described from San Sebastiao, Sao Paulo, Brazil, from both sexes.

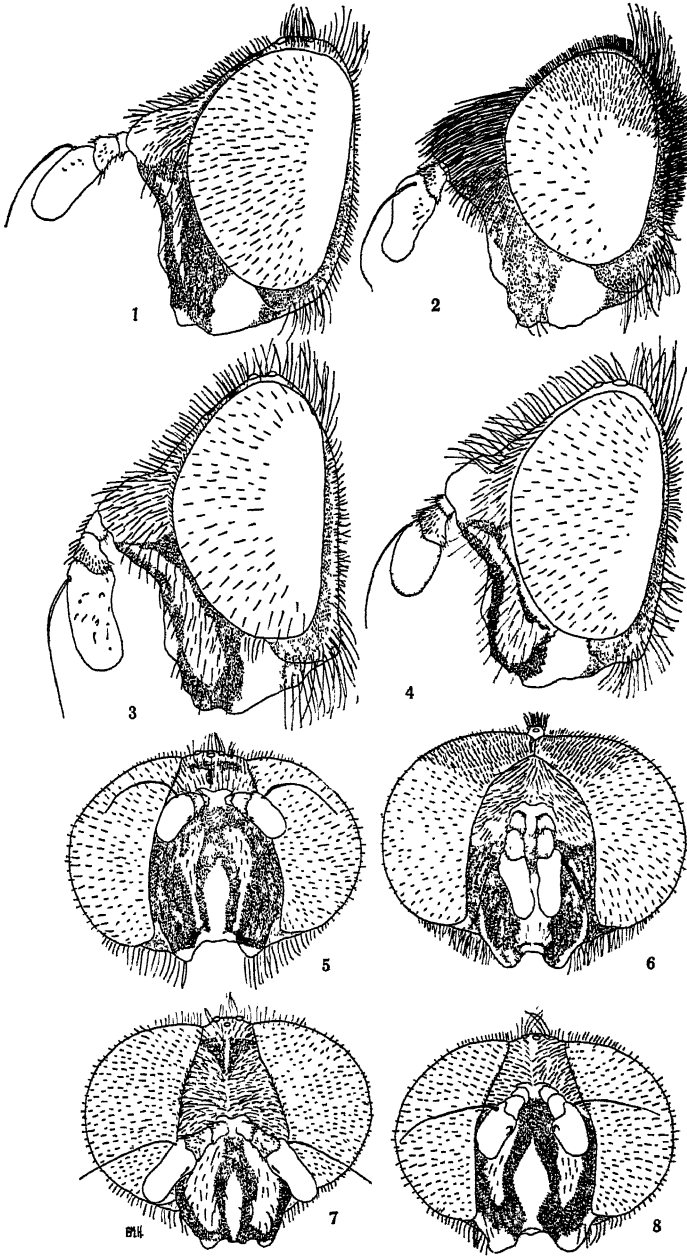
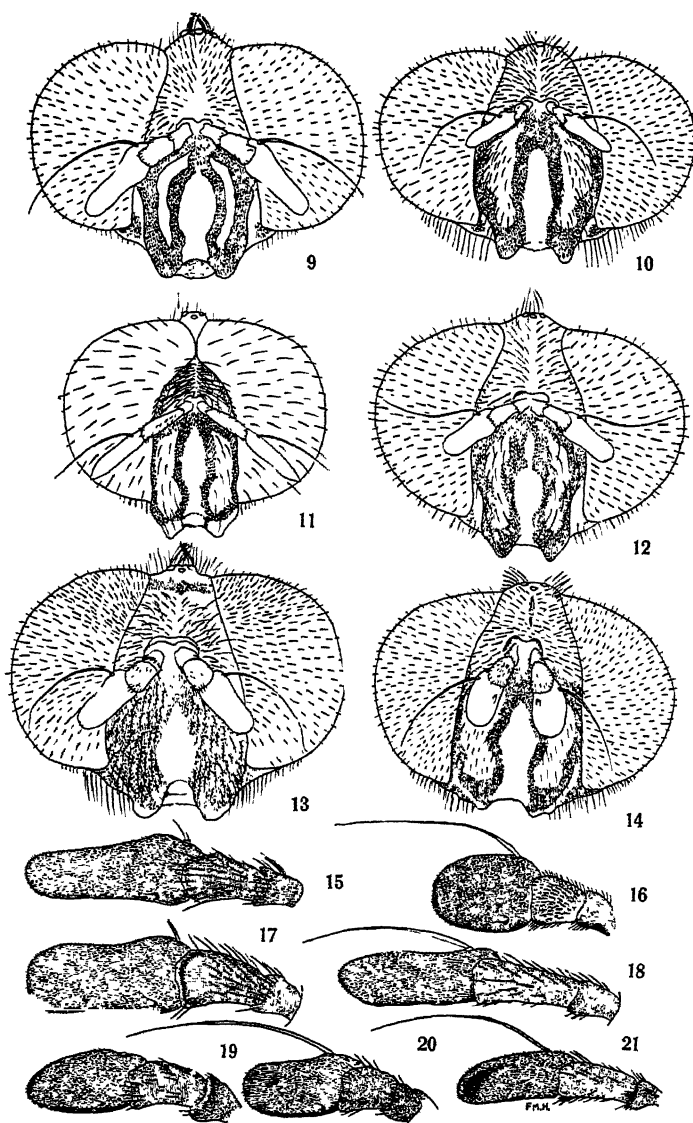


Fig. 1. *Quichuana sepiapennis* Hull, profile of face of female.
 Fig. 2. *Quichuana auratus* Walker, profile of face of male.
 Fig. 3. *Quichuana simonetta*, new species, profile of face of female.
 Fig. 4. *Quichuana cestus*, new species, profile of face of female.
 Fig. 5. *Quichuana sepiapennis* Hull, front of face of female.
 Fig. 6. *Quichuana quizotea*, new species, front of face of male.
 Fig. 7. *Quichuana simonetta*, new species, front of face of female.
 Fig. 8. *Quichuana pogonosa* Fluke, front of face of female paratype.



- Fig. 9. *Quichuana knabi* Shannon, front of face of female type.
 Fig. 10. *Quichuana sylvicola* Knab, front of face of female type.
 Fig. 11. *Quichuana inca* Shannon, front of face of male type.
 Fig. 12. *Quichuana picadoi* Knab, front of face of female type.
 Fig. 13. *Quichuana calathea* Shannon, front of face of female.
 Fig. 14. *Quichuana cestus*, new species, front of face of female.
 Fig. 15. *Quichuana knabi* Shannon, antenna of female type.
 Fig. 16. *Quichuana cestus*, new species, antenna of female.
 Fig. 17. *Quichuana picadoi* Knab, antenna of female type.
 Fig. 18. *Quichuana inca* Shannon, antenna of male type.
 Fig. 19. *Quichuana championi* Williston, antenna of male type.
 Fig. 20. *Quichuana subcostalis* Walker, antenna of female type.
 Fig. 21. *Quichuana cincta* Bigot, antenna of male type.

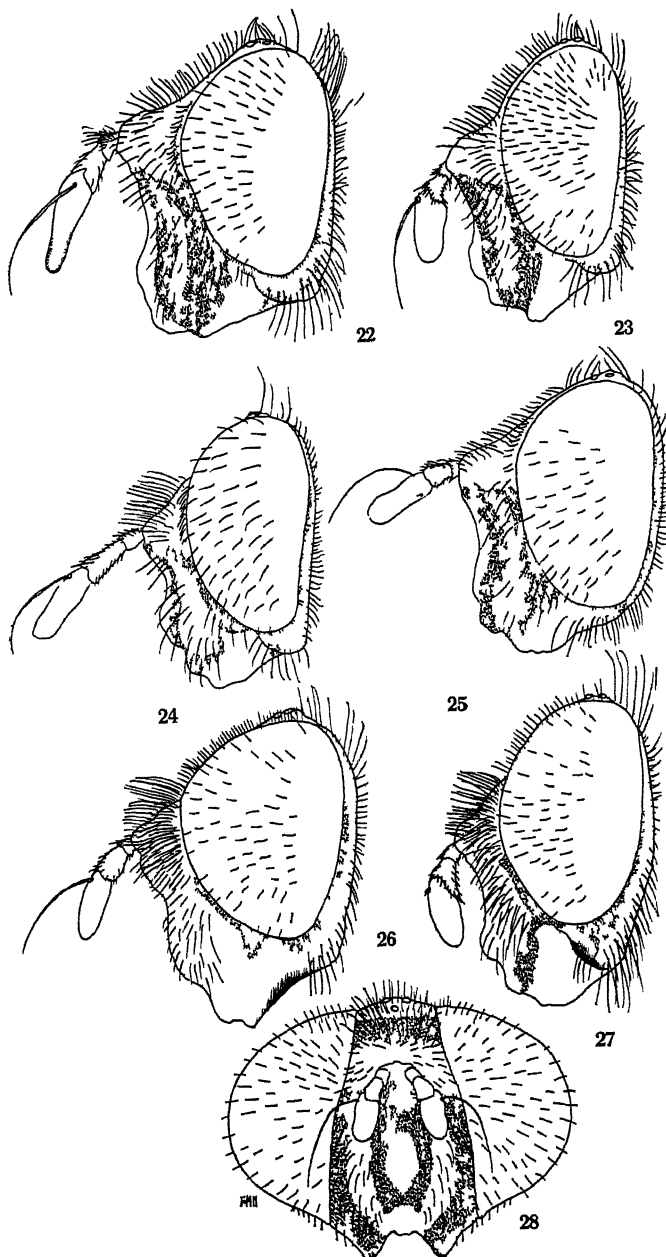


Fig 22 *Qurchuana knabi* Shannon face profile of female type
 Fig 23 *Qurchuana sylvicola* Knab face profile of female type
 Fig 24 *Qurchuana inca* Shannon face profile of female type
 Fig 25 *Qurchuana picador* Knab face profile of female type
 Fig 26 *Qurchuana cincta* Bigot face profile of male type
 Fig 27 *Qurchuana championi* Williston face profile of male type
 Fig 28 *Qurchuana subcostalis* Walker front of face of female type

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DESCRIPTION OF A SIX-YEAR-OLD HYBRID TOAD

BY ALBERT P. BLAIR

Interbreeding has not been reported for the species of toads found in Europe, and it has been shown experimentally (Hertwig, 1936) that the offspring of interspecific matings die early in development. Among the toads of eastern North America, on the other hand, a different situation obtains. Individuals intermediate between *Bufo fowleri* and *B. americanus* have been reported by Miller and Chapin (1910), Deckert (1917), Hubbs (1918), Myers (1927), Pickens (1927), Blair (1941), and numerous other investigators. Harper (1935), Burt (1938), and Blair (1941) have found *Bufo americanus*-*B. terrestris* intermediates; Pickens (1927) and Blair (1941) have reported *B. terrestris*-*B. fowleri* intermediates; Strecker and Williams (1928), Smith (1934), and Blair (1941) have recorded *B. woodhousii*-*B. fowleri* intermediates; Strecker (1915), Bragg (1940), and Blair (1941) have reported *B. americanus*-*B. woodhousii* intermediates; and Blair (1941) has reported *B. fowleri*-*B. valliceps* intermediates. Blair (1941) has made laboratory hybridizations of the following combinations: *americanus*-*fowleri*, *americanus*-*terrestris*, *fowleri*-*terrestris*, *woodhousii*-*americanus*, *fowleri*-*woodhousii*, and *terrestris*-*valliceps*. Offspring of each of these crosses were reared through metamorphosis, and *woodhousii*-*americanus*, *fowleri*-*americanus*, and *woodhousii*-*fowleri* hybrids attained sexual maturity. Male *woodhousii*-*americanus* and *fowleri*-*americanus* were backcrossed to *americanus* and found fertile.

It seems worth while to describe in some detail a male *woodhousii*-*americanus* which attained near maximum growth. This toad was the offspring of a mating between a female *B. woodhousii* from Choteau,

Oklahoma, and a male *B. americanus* from Bloomington, Indiana. Eggs were laid March 25, 1938, after pituitary stimulation. The male hybrid underwent metamorphosis at an age of 69 days and began showing secondary sex characters at 14½ months when its body length (tip of snout to vent) was 51.2 mm. It died February 10, 1944, age 70½ months, of unknown cause.

In dorsal color this toad is more like *americanus* than *woodhousii*, presenting a uniform reddish brown appearance. The parotoid glands are of the same color as the body. The poorly defined middorsal line fades posteriorly. Thumb pads are well developed and heavily pigmented. Pigmentation of the throat is *americanus*-like, with the posterior transverse throat area well defined by heavy pigment in the submaxillary muscle. The entire venter is spotted, a condition sometimes found in *B. americanus* but never in *B. woodhousii*. Toes are strongly webbed as in *B. americanus*. The resemblance is also toward *B. americanus* in the large (2.5-3.0 mm.) dorsal and hind leg warts. A few warts have poorly developed encircling black spots.

In shape the parotoid glands are irregular but more or less oval; their posterior ends diverge widely, as in *B. woodhousii*. The shortest distance between the parotoids is 13 mm. The head is short and broad: width 27 mm. at the level of the tympani, length 13.5 mm. from tip of head to line joining center of tympani. Other measurements (in millimeters), with comparison with male toads from Bloomington and Choteau, are as follows:

	HYBRID	AVERAGE OF 85 <i>B. americanus</i> FROM BLOOMING- TON IND	AVERAGE OF 12 <i>B. woodhousi</i> FROM CHOTEAU, OKLA
Body length	66	56	78
Foot length	41	37	50
Body foot	1 6	1 5	1 6
Parotoid length	14	12	15
Parotoid width	8	6	7
Parotoid length/width	1 75	1 9	2 2

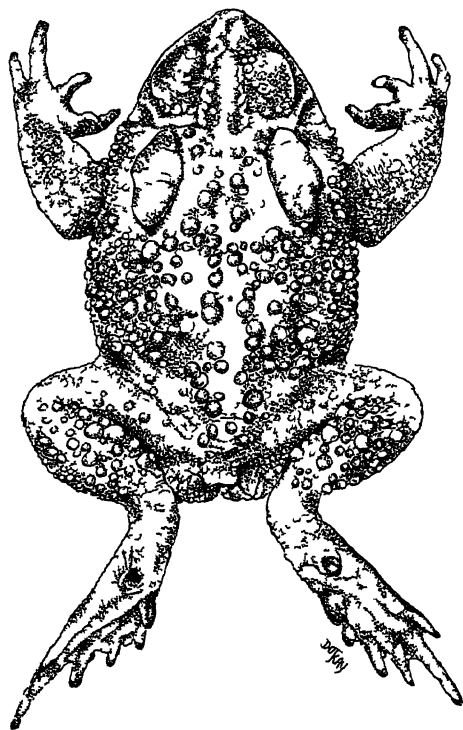


FIG 1 Six-year-old male *woodhousi-americanus* hybrid $\times 1$

The general impression is that the animal is intermediate (fig 1). The large warts, spotted venter, and brown coloration resemble *B. americanus*, but the broad head and widely separated, diverging parotoid glands are strongly reminiscent of *B. woodhousi*.

The testes are rather small: right 8.8, left 9.8 mm in length. The oocytes of Bidder's gland are large and well pigmented. The right Bidder's gland, which is flattened, is roughly 7 mm long and 6

mm wide, the left gland, which is more or less cylindrical, is about 6 mm long and 3 mm in diameter. Vestigial oviducts are prominent.

This animal gave the male chirp and warning vibration when grasped dorsally and was on several occasions found clasping other toads of the same container. It was never heard to call, although exposed at least once to the calls of male toads of one of the parental species (*B. americanus*).

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FOSSIL SPIDERS IN THE COLLECTION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

BY ALEXANDER PETRUNKEVITCH

BALTIC AMBER SPIDERS

The collection that forms the basis of the present study consists of 28 specimens distributed over 12 families, 18 genera, and 21 species. One of the genera is new, although it has for type a species described by Koch and Berendt, but wrongly placed by them in another genus. Four species are also new. The male of a species formerly known only from a female, and the female of another species established on the basis of a single immature male are described here for the first time. Three of Koch and Berendt's species inadequately described by them are here described in great detail. Two of the families do not appear in my "A study of amber spiders," published in 1942, and their presence in the collection of the American Museum is of special interest. The first of these, the family Dipluridae, belongs to the Suborder Mygalomorphae and is represented by a single specimen belonging to the species *Clostes priscus* which was de-

scribed by Menge in 1869, also on the basis of a single specimen. It is the only representative of the suborder known to science from Baltic amber. The second family, Anyphaenidae, represented by a single specimen of the species *Anyphaena fuscata* Koch and Berendt, belongs to the Branch Quadrostiata of the Suborder Dipneumonomorphae. It furnishes additional proof to the contention that the larger groups of spiders must have evolved at a considerably earlier geological period.

My thanks are due to the Chairman of the Department of Geology and Paleontology of the American Museum, Dr. G. G. Simpson, and to the Associate Curator of Fossil Invertebrates, Dr. Otto H. Haas, for the loan of the specimens, as well as to Dr. W. J. Gertsch of the Department of Insects and Spiders for having called my attention to the existence of this collection and to the presence of a mygalomorph in it.

SUBORDER MYGALOMORPHAE

BRANCH OCTOSTIATAE

FAMILY DIPLURIDAE

Subfamily Macrothelinae

GENUS CLOSTES MENGE, 1869

When the genus *Clostes* was established by Menge for the single species *C. priscus* found in Baltic amber, the classification of mygalomorph spiders was still very little understood. Menge states: "Ich habe daher eine zwischen Clotho und Mygale stehende gattung aufgestellt" (p. 7). Now the genus *Clotho* is a synonym of *Uroctea* and therefore a dipneumonomorph spider. The genus *Mygale* is a synonym of *Poecilotheria*

which is a mygalomorph spider of the family Theraphosidae. But in the sixties of the past century numerous mygalomorph spiders were placed under the genus *Mygale*, such as *Diplura macrura* (C. L. Koch), 1842; *Brachythele ictérica* (C. L. Koch), 1842; *Trechona lycosiformis* (C. L. Koch), 1842; *Trechona venosa* (Latreille), 1830; and *Trysothele subcalpetana* (Nicolet), 1849. All these species are now placed in the family Dipluridae. It seems strange that an arachnologist of the caliber of Menge, familiar with Koch's great work and figures, did not recognize the striking resemblance of his *Clostes priscus* to these diplurid spiders. His figure and descrip-

tion of *Clostes priscus* leave no doubt of its affiliation with the family Dipluridae, and the American Museum specimen fully confirms this relationship. The slight discrepancy in the relative length of the legs and in the number of teeth in the claws is of no great value and may be owing to poorer instruments, difficulties of correct measurement, or difference in the instar or sex. Menge's definition of the genus is quite inadequate from the modern point of view. For this reason a new definition is given here:

Eight eyes on a transversely ellipsoidal tubercle. Both rows slightly procurved. Anterior median eyes the smallest, anterior lateral eyes the largest, of the group. Lateral eyes contiguous and median eyes contiguous with their respective lateral eyes. Quadrangle of eyes considerably wider behind than in front. Carapace fairly low. Thoracic groove recurved. Legs with bristles, but devoid of spines. Order of legs 4123. Three claws. Upper claws dissimilar, pectinate in a single row. Claw tufts and scopulae wanting. Four spinnerets. Posterior pair wide apart, approximately as long as two-thirds of the abdomen, their third joint straight, longer than the second joint. Type, *C. priscus* Menge.

The genus *Clostes* may be differentiated from related Recent genera of the same subfamily as follows: It differs from *Ischothele* by the relatively greater length of the third joint of the posterior spinnerets in the latter; from *Macrothele*, to which it is most closely related, by the absence of spines on the legs; and from *Porrhothele* by its eyes (in *Porrhothele* the posterior median ones are smaller than the anterior median ones) and by the fact that in *Porrhothele* the first pair of legs is much the stoutest, whereas in *Clostes* all legs are more or less equally stout.

Clostes priscus Menge

Figures 1-6, 79

Clostes priscus MENGE, 1869, Schr. Naturf. Gesellsch. Danzig, new ser., vol. 2, fasc. 2, pp. 6-7, figs. A, B.

The spider (A.M.N.H. No. 26254) is in fairly clear amber which unfortunately has pockets filled with air. Two of them were so large that it was necessary to remove them by drilling and then by filling the cavity with a solution of clarite. The ventral surface of the specimen is heavily coated with white emulsion which makes the lip, sternum, maxillae, venter of abdomen, and the pair of anterior spinnerets invisible. The dorsal surface is clear. The specimen is distorted, its abdomen being pressed toward the right side at an angle of about 45 degrees. The legs of the left side have been mutilated by some previous owner in the process of cutting, and lack the tarsi and portion of the metatarsi. The right legs are complete, but are bent under the spider. The carapace and the chelicerae are almost black, the abdomen and the appendages dark brown.

Total length with chelicerae but without spinnerets 4.5 mm. (This figure represents the sum of separate measurements of the carapace and abdomen in the median line.) Carapace 1.65 mm. long, 1.55 mm. wide, with evenly rounded sides as shown in figure 1. In the region of the eye tubercle the width of the carapace is only 0.85 mm. Abdomen 2.25 mm. long, 1.20 mm. wide. Posterior spinnerets 1.75 mm. long; their first joint 0.50 mm., second joint 0.50 mm., third joint 0.75 mm. The basal joint of chelicerae 0.60 mm. long.

In the specimen described here the first and second legs are equally long, but in Menge's specimen the first leg is given as being considerably longer than the second.

LEGS	FEMUR	PATELLA	TIBIA	METATARSUS	TARSUS	TOTAL
I	1.35	0.60	1.00	0.95	0.75	4.65
II	1.35	0.60	1.00	0.95	0.75	4.65
III	1.15	0.60	1.00	0.95	0.75	4.45
IV	1.40	0.65	1.20	1.40	0.80	5.45
Palp	0.90	0.50	0.90		0.70	3.00

Leg formula -

3.3 2.8 2.8 2.7

According to Menge the total length of the legs is: I, 7.5; II, 6; III, 4; IV, 8 mm. It is possible that his specimen was an immature male. It had a claw at the end of the palp, but we know now from observations on living species that in mygalomorph spiders the palp of the male shows no swelling even in the penultimate instar and presents the appearance of a female palp.

Width of first patella 0.275 mm., of second, third, and fourth 0.250 mm. First tibial index 17.1, second 15.6, third 15.6, fourth 13.5.

Femur of palp distinctly curved laterally, concave toward the chelicerae. Femur of fourth leg very slightly curved downward, convex dorsally. All femora straight. Claws (fig. 2) visible on all four legs of the right side. Upper claws long, slender, dissimilar, but both pectinate in a single row. The retroclaw is slightly bent at distal third and the teeth occupy the middle third. There are five teeth, unless one counts as the sixth one the small tubercle shown in our figure. The proclaw is more or less evenly curved, and its teeth occupy the proximal half. They are longer and stouter than those of the retroclaw, and there are eight of them, the proximal one being quite small. Menge did not notice the dissimilarity of the claws in his specimen, but in his

time no attention was paid to this character. His figure was presumably made from the proclaw. On the first three legs of our specimen the proclaw is turned in such a manner as to make the claws invisible, while the proclaw of the fourth leg shown in our figure is broken off beyond the distal tooth. The third claw is stout, smooth, thorn-like. Claw tufts are wanting, as well as spines; but stout, long bristles are present on all legs. Scopulae are wanting. Trichobothria are visible only on the tibiae where they are arranged in two rows, four in each row, increasing in length distally.

The spinnerets are clothed with long hair having the appearance of slender bristles. On the terminal and median joints several spinning tubes are visible (fig. 6). They have a short, stout base and a slender and very long shaft which is fully as long as the common hair and may be easily mistaken for it. At least one spinning tube is visible at the end of the basal joint in both spinnerets.

The abdomen is clothed with stout, curved bristles. The surface of the dorsal abdominal wall appears wrinkled.

The chelicerae are provided with a few long and stout bristles, but lack a rastellum. Only a portion of the right fang is visible. They were not visible in Menge's specimen.

SUBORDER DIPNEUMONOMORPHAE

BRANCH TRIONYCHAE

FAMILY ERIGONIDAE

GENUS *Eogoniatium* PETRUNKEVITCH, 1942

Eogoniatium robustum, new species

Figures 7-10, 71

HOLOTYPE: A.M.N.H. No. 26255. Female, presumably in penultimate instar. An unusually well-preserved specimen in almost perfectly clear amber.

Total length 3.2 mm. Carapace 1.15 mm. long, 1.00 mm. wide, 0.37 mm. high, with a semilunar depression in the place of the thoracic groove. Eye group 0.45 mm. wide; almost, but not quite so wide as the head. First row of eyes strongly recurved, second row gently procurved (fig. 10). Laterals at each side of the head contiguous, on a single

tubercle. Quadrangle wider in front than behind in ratio 22:20 and wider than long in the same ratio. Ratio of eyes AME: ALE:PME:PLE = 9:8:8:8. AME separated from each other by one-third of their diameter and from the ALE by only two-ninths of their diameter. PME separated from each other by three-quarters of their diameter and from the PLE by their radius. Clypeus equal to one-third of the diameter of the AME. In face view (fig. 8) the anterior row of eyes is slightly up-curved, the posterior row distinctly down-curved and somewhat longer than the anterior row. A median row of slender bristles and a few scattered ones are present on the carapace, but otherwise its surface is smooth.

Chelicerae more or less geniculated, their

outer edges parallel, their inner ones diverging. The margins are oblique, promargin smooth, retromargin with three pointed teeth. Boss wanting. Fang evenly curved. Maxillae projecting considerably beyond the chelicerae as shown in figure 8. In face view the serrula can be seen plainly on the left maxilla, and the edge of the right maxilla is visible all the way to the insertion of the palp. The ventral view is obstructed by bubbles and imperfections of the amber. The lip is consequently not visible.

Sternum longer than wide in ratio 55:45. pointed between the hind coxae which are separated by less than one-quarter of their width. First coxae wide apart. The sternum is distinctly, but not strongly convex.

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	1.25	1.32	0.95	0.55	4.07
II	0.90	1.00	0.62	0.42	2.94
III	0.70	0.70	0.42	0.35	2.17
IV	0.90	0.90	0.50	0.35	2.65
Leg formula	1 2 4 3				
	3.5 2.5 2.3 1.9				

Width of first patella 0.245 mm. First tibial index 19

Width of fourth patella 0.215 mm. Fourth tibial index 24

Three claws. Upper claws similar, evenly curved, smooth. Third claw bent at right angles, smooth. Palpal claw gently curved, smooth. Serrated bristles, claw tufts, and scopulae wanting. Legs clothed with simple hair of two kinds, more numerous longer hair directed at an angle forward and much less numerous short hair standing erect especially on tarsi. No trichobothria can be seen.

Abdomen ellipsoidal, evenly rounded at both ends, distinctly flattened above, 1.85 mm. long, 1.55 mm. wide, 1.25 mm. high.

Six spinnerets forming a rosette (fig. 9). Anterior pair somewhat stouter, contiguous. Colulus well developed. In front of it the tracheal spiracle is plainly visible, a very unusual feature in fossil species, often difficult to see even in Recent species. On tipping the specimen one can see in front of the genital fold a not yet fully developed epigyne. It has the shape of a small, transverse plate with a pair of round receptacles under it. The abdomen is sparsely clothed with stout hair standing at an angle to the surface.

The species may be distinguished from *E. minutum* by its larger size and the proportion of the eyes; from *E. succini* by the fact that its four anterior eyes are not contiguous and its clypeus is much lower.

FAMILY AGALENIDAE

Subfamily Agaleninae

GENUS EOCRYPHOECA, NEW

DEFINITION OF GENUS: Spinnerets forming a trapeze, anterior pair closer together than the posterior one, yet separated by at least their diameter. Anterior spinnerets with a hemispherical second (terminal) joint, posterior ones with a cone-shaped second joint which is much shorter than the

basal joint and bears a few spinning tubes. Eyes in two rows, both procurved when viewed from above, slightly downcurved in face view. Anterior median eyes smallest. Armature of chelicerae not known. Closely related to *Cryphoea*, but has relatively longer legs with somewhat different disposition of spines and relatively much less difference in the size of the eyes of the first row. Type, *E. gracilipes* (Koch and Berendt).

Eocryphoea gracilipes (Koch and Berendt)

Figures 11-21, 78

Tegenaria gracilipes KOCH AND BERENDT, 1854, Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt, p. 47, pl. 16, fig. 139.

HOLOTYPE: A.M.N.H. No. 26256.

Koch described two species under the generic name of *Tegenaria*, namely, *T. obscura* and *T. gracilipes*. If one can judge by the figures, the two spiders are very different in appearance. The characters now considered to be of primary importance

for the recognition of the genus are either invisible, as in the case of the spinnerets in his specimen of *T. gracilipes*, or else insufficiently described. Both Koch and Menge, who edited Koch's monograph, were of course fully familiar with Recent European species of *Tegenaria*. In a footnote accompanying Koch's description of *T. obscura*, Menge states that in his opinion that species undoubtedly belongs to the genus *Tegenaria* because of the disposition of its eyes and the longer posterior spinnerets—"gehört nach der Stellung der Augen und den längern hintern Spinnwarzen wohl zu *Tegenaria*" (p. 47). Of the eyes of *T. gracilipes*, Menge says that they are somewhat different from those of Recent species. Unfortunately species were referred at that time to the genus *Tegenaria* which have since been removed to the genera *Cryphoea* and *Cicurina*. The description of *T. gracilipes* given by Koch, including Menge's footnote, is insufficient to place that species in a proper genus. If, nevertheless, I refer specimen A.M.N.H. No. 26256 to Koch's species I do so because of its resemblance to Koch's figure and also because it is probable that it belongs to that and not to a different species. The new genus *Eocryphoea* had to be erected because the spinnerets and eyes are sufficiently well visible to require the removal of the species from the genus *Tegenaria*. The same characters do not permit the inclusion of the species in any Recent genus.

DESCRIPTION OF HYPOTYPE: It is a well-preserved specimen in clear amber which, however, has a dirty plane separating the view of the spider in such a manner that only the eye group and portion of the abdomen are visible on the one side of the plane. Apparently the spider was caught in a small quantity of resin which became hardened on the surface with particles of dust adhering to it, before a new layer of resin enveloped the rest of the body and the legs. On the ventral surface some white emulsion obstructs the view of a portion of the abdomen, median spinnerets, and chelicerae, so that only the fang of the right chelicera and part of the left chelicera may be seen.

Total length 3.84 mm. Carapace 1.65 mm. long, 1.10 mm. wide in region between

second and third coxae, with head sharply set off and having parallel sides so that the width of the head is 0.70 mm. The eye group (fig. 15) is much narrower than the head. In side view (fig. 19) the carapace appears highest at the thoracic groove which is longitudinal and from which the cephalothoracic and thoracic sulci radiate. The thoracic portion of the carapace has such strongly convex sides that it has almost the shape of a circle. A median row of bristles extends from the thoracic groove forward to the eye group. The surface of the carapace is sparsely clothed with recumbent simple hair directed forward in the middle, forward and upward on sides. The eye group is 1.00 mm. wide and consists of two procurved and downcurved rows. The posterior row is longer than the anterior one and consists of four equal and equidistant eyes (fig. 18) separated from each other by four-tenths of their diameter. The eyes of the first row are subcontiguous, though clearly separated. Ratio of eyes AME: ALE:PME:PLE = 7:8:10:10. The quadrangle is slightly wider than long in ratio 22:20, wider behind than in front in ratio 22:14. The clypeus is concave, not higher than lateral eyes, with a row of short bristles on the margin.

Chelicerae parallel, rather short, fairly stout, not geniculated. Boss present (fig. 15). Fang short, evenly curved. Margins not visible.

Maxillae parallel by inner edges. Lip trapezoidal, distinctly wider than long, extending just beyond the middle of the maxillae.

Sternum a little longer than wide (fig. 16), fairly flat, broadly truncated in front, bluntly pointed behind. First coxae wide apart, fourth coxae separated by about their width.

SPINES: First leg: Femur dorsal 1-1-1 (distal spine quite small), prolateral 1-1-1, retrolateral 0, ventral 1-1-1-1-1 bristles. Patella dorsal 1-1 bristles, elsewhere 0. Tibia prolateral 1-0-0, ventral 2-2-2, elsewhere 0. Metatarsus ventral 2-2-2, elsewhere 0. Second leg: Same as first except tibia dorsal 1-1, metatarsus prolateral 0-0-1, retrolateral 0-0-1. Third leg: Femur dorsal 1-0-0, prolateral 0-0-1, retrolateral

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	1 25	1.55	1.10	0.75	4.65
II	1 25	1.45	0.90	0.70	4.30
III	1.10	1.25	0.90	0.60	3.85
IV	1.40	1.65	1.30	0.75	5.10
Palp	0 55	0 55		0.60	1.70

Leg formula	4	1	2	3
	3.0	2.8	2.6	2.3

Width of first patella 0.175. First tibial index 11

Width of fourth patella 0.200. Fourth tibial index 12

0-0-1, ventral an irregular row of bristles. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 2-2-2. Metatarsus dorsal 0-0-1, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2. Fourth leg: Same as third except metatarsus dorsal 1-0-1.

Trichobothria few. On tarsi a single row of four trichobothria is present, increasing in length distally (fig. 20). A few scattered trichobothria are also present on metatarsi and tibiae, but they are difficult to see on account of their shortness and slender appearance. The legs are clothed with simple hair which is stout, especially on tarsi. The spines are also stout and long; those on the palpi are curved and partly obstructed from view. On the femur of the palp one can see at least one dorsal spine, on the patella 1-1 dorsal spines. On the tibia dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 0. Terminal joint with no fewer than nine spines, their exact disposition not clear, but found on all surfaces.

Three claws. Upper claws similar, slightly bent, with a row of slender teeth in basal half (fig. 21), increasing in length distally, their counting difficult, but apparently seven or eight. Third claw bent, smooth. Palpal claw almost straight, smooth. Serrated bristles, spurious claws, and scopulae wanting on all legs. None of the trochanters notched.

Abdomen ovoid, pointed behind, rounded in front and considerably overlapping the carapace. The spinnerets are terminal. Of the median pair only the terminal bristles are visible. Those of the anterior pair are two-jointed, cylindrical, with the second joint hemispherical (fig. 14), separated at base by more than their diameter. The posterior spinnerets are also two-jointed, but their basal joint is as long as

an entire anterior spinneret, and their second joint is cone-shaped (fig. 14) and much shorter than the basal joint. The posterior spinnerets are inclined toward each other (fig. 13) and are separated at base by about two of their diameters and from the anterior pair by about their radius. The bases of the four spinnerets form therefore a regular trapeze. Several spinning tubes can be seen at the end of the cone-shaped second joint, but their number seems to be small, about six at most. The anal tubercle is small. A colulus is wanting.

The abdomen is clothed with stout brown hair standing at a considerable angle to the surface. I am unable to see any plumose hair either on the abdomen or on the legs.

Myro fossilis described by me under that genus in my "A study of amber spiders" is not a *Myro* but an *Ecocyphoea*. It may be separated from *E. gracilipes* by the disposition of the eyes, the second row of which is much farther apart in *E. fossilis* than in *E. gracilipes*.

FAMILY INSECUTORIDAE

GENUS INSECUTOR PETRUNKEVITCH, 1942

Insecutor aculeatus Petrunkevitch

Figures 22, 77

Insecutor aculeatus PETRUNKEVITCH, 1942, A study of amber spiders, p. 239, pl. 20, figs. 186-192, pl. 26, figs. 246-247, pl. 27, fig. 251, pl. 61, figs. 560, 561.

The American Museum of Natural History has five specimens of this species (A.M.N.H. Nos. 26257:1-26257:5). Specimens A.M.N.H. Nos. 26257:3-26257:5 present no new features. All three seem to be young females. A.M.N.H. No. 26257:3 is especially well preserved.

Specimen A.M.N.H. No. 26257:1, although incomplete and damaged, presents

many interesting features. The posterior half of the abdomen must have been lost before the spider became fully enclosed in amber. Consequently one is enabled to look into the interior portion of the abdomen. The passage into the petiolus, filled with white emulsion, is plainly visible, but

Carapace 1.75 mm. long, 1.40 mm. wide. Width of head in the region of the posterior row of eyes 0.80 mm. First row of eyes 0.60 mm., second row 0.72 mm. Ratio of eyes AME:ALE:PME:PLE = 2.5:4.5:4.5:5.5. Quadrangle wider behind than in front in ratio 13:10, as long as wide behind.

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	1.90	2.30	1.75	0.85	6.80
II	1.90	2.35	1.80	0.90	6.95
III	1.70	2.00	1.60	0.75	6.05
IV	1.90	2.00	1.85	0.80	6.55
Palp	0.75	0.75		0.85	2.35
Leg formula	2	1	4	3	
	4.0	3.8	3.7	3.5	

Width of first patella 0.275 mm. First tibial index 12

Width of fourth patella 0.275 mm. Fourth tibial index 13

the lungs have completely disintegrated, leaving no trace of their existence. Absence of an epigyne or of receptacles proves that the specimen was immature. Its chief interest, however, lies in the fact that the view of the chelicerae is not obstructed either by emulsion, which is the usual case, or by imperfections of the amber. One gets a clear view of the margins and of the fang (fig. 22). The promargin has no teeth and only a very scanty scopula composed of a single row of seven bristles. The retromargin has no scopula, but is armed with three small teeth, the central one being the largest. Behind the chelicerae one can see the rounded edge of the maxillae with a few marginal bristles and somewhat away from the margin the serrula. The cheliceral boss can also be seen at the base of the left chelicera, but it is poorly developed.

Specimen A.M.N.H. No. 26257:2 (fig. 77) looks at first glance somewhat different from the others. This is owing partly to the fact that all its legs are turned under the ventral surface so that they can be studied only by turning the specimen, examining it in different positions; and partly because all hair seems to be preserved and heavily coated with white emulsion.

A detailed description of the specimen, such as I have in my original notebook, is not needed here. The deviations from characters given in the description of the type are only of a subordinate kind. Only measurements are therefore given here.

Upper claws with four teeth. Third claw smooth.

Insecutor mandibulatus Petrunkevitch

Figures 23-25, 73

Insecutor mandibulatus PETRUNKEVITCH, 1942, A study of amber spiders, p. 244, pl. 26, figs. 238-245, 248, pl. 27, figs. 249, 250, pl. 60, fig. 559, pl. 61, fig. 563, pl. 66, fig. 599.

The type and paratype of this species are apparently immature females. The American Museum of Natural History has two specimens (A.M.N.H. No. 26258:1, 26258:2). A.M.N.H. No. 26258:1, which may be a mature female, is well preserved. The epigynal region is covered with a layer of emulsion. However, if the specimen is examined in very strong transmitted light at a certain angle, a portion of an organ can be seen which may be the left receptacle with a short duct. The view of the right receptacle is unfortunately obstructed by the fourth leg.

Carapace 1.85 mm. long, 1.50 mm. wide. Abdomen 2.15 mm. long. Second leg: Femur 2.00, patella + tibia 2.50, metatarsus 18.5, tarsus 0.90, total 7.25 mm.

Specimen No. 26258:2 (figs. 23-25, 73) is a mature male. There seems to be little doubt that it belongs to the same species as the type and must therefore be regarded as androtype. It is a well-preserved specimen. The amber is very dark and full of imperfections; portions of some legs are missing, but all important features are visible and both palpi can be seen without difficulty.

Total length 5.55 mm. Carapace 2.5 mm. long, 2.3 mm. wide. Head in the region of the second row of eyes 1.12 mm. wide. The eye group is shown in figure 25. Both rows are slightly recurved. The lateral eyes are widely separated, yet are on joint tubercles. Width of eye groups 1.00 mm. Ratio of eyes AME:ALE:PME:PLE = 9:11:10:10. Quadrangle wider behind than in front in ratio 34:25, wider than long in the same ratio. Carapace, face, and chelicerae have the same shape and structure as in the type.

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	4.48	5.92	4.48	2.08	16.96
II	4.48	5.92	4.64	2.08	17.12
III	3.36	4.80	3.52	2.08	13.76
IV	4.00	4.16	4.16	2.08	16.40
Palp	1.50	1.24		1.62	4.30
	2	1		4	3
Leg formula					
	6.85	6.78	6.56	5.50	

Tibia and patella of the palp are equally long. The spines on the legs have the same disposition as in the type. Upper claws (fig. 23) have a single row of 16 slender teeth. The sternum has the same shape as in the type. The lip is not visible. The palpi are very characteristic (fig. 24). The tibia has a powerful dorsal apophysis. The copulatory apparatus has an enormous ventral, cone-shaped apophysis with its pointed end turned slightly upward. The embolus has the shape of a fine spiral forming apparently a single turn.

The spinnerets are heavily coated with emulsion.

FAMILY THERIDIIDAE

Subfamily Theridiinae

GENUS *FLEGIA* KOCH AND BERENDT, 1854

Flegia longimana Koch and Berendt

Figures 26-32, 72

Flegia longimana KOCH AND BERENDT, 1854, Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt, p. 29, pl. 3, fig. 18.

Koch gave a sufficiently good description with a figure which makes it possible to identify the species. He had a single male specimen which was clear on the dorsal surface, but coated on the venter. Chelicerae, maxillae, lip, and sternum remained there-

fore unknown. According to a footnote on page 30, Menge had seven specimens of this species, all of them males, but in one piece of amber besides a male a female was also present. Menge gives some information concerning the eye tubercle, chelicerae, sternum, and copulatory apparatus of the male.

Specimen A.M.N.H. No. 26259 is a beautifully preserved male in perfectly clear amber (figs. 26-32, 72). It is visible from all sides, and only the chelicerae are

coated with emulsion and cannot be seen clearly. An air bubble obstructs the view of the copulatory apparatus of the right palp, but the left palp is clearly visible.

Total length 2.66 mm. Carapace 1.12 mm. long, 1.12 mm. wide. Its shape is very characteristic owing to the curvature of the right and left halves of its thoracic portion, giving it an appearance which Koch likened to cheeks. The head is elevated and separated from the thorax by deep grooves. The carapace is glabrous. The sternum shown in figure 31 is longer than wide, very convex, pointed and slightly bifid at posterior end. The lip is wider than long. The maxillae are inclined over the lip. The first coxae are wide apart. The fourth coxae are separated by the end of the sternum.

Spines on legs wanting, but dorsal bristles present on all legs as follows: patella 1-1, tibia 0-1-1. Legs clothed with simple hair. Fourth tarsi with a comb of serrated bristles, one of which is shown at high magnification in figure 28. Trichobothria are present on tibiae and metatarsi, but being rather short they are difficult to see. The upper claws are similar (fig. 30), with three or four teeth. Third claw as large as upper claws, but smooth (fig. 29). Two spurious claws are present (fig. 32).

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	2.45	2.80	2.52	0.70	8.47
II	1.75	1.75	1.61	0.63	5.74
III	1.19	1.19	1.05	0.56	3.99
IV	2.45	2.45	2.45	0.91	8.26
Palp	1.12	0.91		0.70	2.73

Leg formula	1	4	2	3
	7.5	7.4	5.1	3.6

Width of first patella 0.15 mm. First tibial index 5.1

Width of fourth patella 0.15 mm. Fourth tibial index 6.1

Abdomen 1.61 mm. long, 0.84 mm. wide, sparsely clothed with long, stout, curved hair.

Subfamily Latrodectinae

GENUS *EODIPOENA* PETRUNKEVITCH, 1942

Eodipoena oculata Petrunkevitch

Figures 33, 34

Eodipoena oculata PETRUNKEVITCH, 1942, A study of amber spiders, p. 272, pl. 17, figs. 160-168, pl. 61, fig. 565.

The type of this species is in the British Museum and is a mature female of 4.1 mm. in length. The American Museum of Natural History has a specimen (A.M.N.H. No. 26260, figs. 33, 34) which I refer to this species with some doubt because of the difference in size and some discrepancies in structure. However, the differences are not so great as the similarities, as may be judged by the following description.

This specimen is rather poorly preserved in very imperfect amber. The little spider clings with its four anterior legs to a large bubble filled with white emulsion, air, and dirt. It was necessary to drill a hole to the bubble, insert a fine canule of glass, suck up the air with loose debris, and then fill the cavity with cedar oil. In the process of such fine procedure the tip of the extremely fine canule broke off and slipped into the cavity of the bubble where it now permanently remains. However, many important structures not visible before the operation are now apparent.

The little spider is so twisted in the amber that its abdomen is almost at right angles to the cephalothorax. The legs are complete and can be measured, but the comb of the fourth tarsi cannot be seen except when the specimen is inclined at a considerable angle. Four long bristles then become visible in the distal half of the left tarsus, making the

existence of the comb certain and suggesting that it is actually composed of seven or eight bristles. The claws cannot be seen clearly. The posterior edge of the carapace can be seen only in profile because almost half of the carapace is hidden under the anterior end of the abdomen. The eye group (fig. 34) is visible both from above and from in front, but measurements are difficult and unsatisfactory. The chelicerae can be seen in only one position, otherwise their view is obstructed by the first pair of legs. Neither sternum nor mouth parts are visible. The six spinnerets are clearly visible, but the view of the colulus, if there is one, is completely obstructed by dirt. A ventral median ridge of dirt extends from the spinnerets forward, obstructing the view of the genital fold, but the swelling in that region is possibly due to the presence of an epigyne under the dirt.

Total length ca. 2 mm. Carapace 0.72 mm. long, 0.80 mm. wide (fig. 33), strongly narrowed in front. The eye group is only 0.40 mm. wide, and the lateral eyes project beyond the outline of the head. The carapace is fairly level and has a transverse depression in place of the thoracic groove. A median line of bristles, visible only in profile, extends from the depression forward. The eye group is on a joint ellipsoidal tubercle. The eyes are all of about the same size. The laterals are contiguous, but are slightly separated from the medians. The AME and the PME are separated, each pair, by about their radius. The quadrangle is about square. The first row of eyes is recurved, the second slightly procurved. Clypeus slightly lower than quadrangle.

Chelicerae very small, virtually without margins. Fang slender, pointed.

Spines on legs wanting, but the usual

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	0.87	0.87	0.57	0.37	2.68
II	0.67	0.72	0.45	0.35	2.19
III	0.52	0.60	0.42	0.25	1.79
IV	0.87	0.87	0.60	0.40	2.74
Palp	0.25	0.22		0.22	0.69
	4	1 2 3			
Leg formula	3.8 3.7 3.0 2.5				

dorsal bristles 1-1 are present on the patella. The legs are clothed with simple hair.

Abdomen ovoid, 1.9 mm. long, 1.25 mm. high, 1.50 mm. wide. It is clothed with stiff hairs. The spinnerets are typical, situated in a rosette. The anal tubercle is cone-shaped and rather large, widely separating the posterior spinnerets.

Eodipoena baltica, new species

Figures 35-38, 69

HOLOTYPE: A.M.N.H. No. 26261. Mature female. Except for some emulsion on the abdomen and a few air bubbles, the specimen is well preserved in clear amber.

Total length with chelicerae 2.5 mm. Carapace about 0.95 mm. long. (Exact measurement is impossible on account of the shape of the spider; see fig. 35.) Abdomen ovoid, 2.0 mm. long, 1.5 mm. high, 1.75 mm. wide, rounded in front. Sternum as long as wide, fairly convex, bluntly pointed between the hind coxae which are separated by their width. First coxae wide apart. Chelicerae neatly cone-shaped, their armature as well as the fangs not visible.

The legs are clothed with simple hair of

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	1.10	1.15	0.75	0.50	3.50
II	0.90	0.90	0.65	0.50	2.95
III	0.75	0.65	0.45	0.40	2.25
IV	1.00	1.00	0.65	0.50	3.15
Palp	0.30	0.32		0.35	0.97
	1	4 2 3			
Leg formula	3.7 3.3 3.1 2.4				

Width of first patella 0.137 mm. First tibial index 3.9

Width of fourth patella 0.150 mm. Fourth tibial index 4.7

two kinds: one is longer and inclined forward; the other shorter and erect, with larger intervals between the hairs. The comb of the fourth tarsi is well visible and is composed of seven bristles. The claws are smooth. The third claw is bent at right angles. Scopulae, claw tufts, and spines

are wanting, but the usual dorsal bristles 1-1 are present on patellae and tibiae and are rather stout and long.

The eye group is shown in figures 36 and 38. The maxillae are converging over the lip which is much wider than long.

The epigyne (fig. 37) resembles that in the other two species of the genus. On each side a row of dots is visible. I think that they represent nodes of a convoluted tubule or duct which opens presumably into the atrium. The latter has the shape of an inverted V.

The three species of *Eodipoena* may be distinguished as follows:

- Order of legs 4123. *E. oculata*
Order of legs 1423. 2
- Size larger, 4 mm. Legs relatively shorter and stouter, first leg only 2.8 times as long as carapace. Sternum distinctly longer than wide.
Size smaller, 2.5 mm. Legs relatively longer and more slender, first leg 3.7 times as long as carapace. Sternum as long as wide.
Size smaller, 2.5 mm. Legs relatively longer and more slender, first leg 3.7 times as long as carapace. Sternum as long as wide. *E. baltica*, new species

Subfamily Mysmeninae

GENUS MUNICEPS PETRUNKEVITCH, 1942

Municeps pulcher Petrunkevitch

Municeps pulcher PETRUNKEVITCH, 1942, A study of amber spiders, p. 281, pl. 8, figs. 73-75, pl. 58, fig. 540.

The specimen in the collection of the American Museum (A.M.N.H. No. 26262) is a very young spiderling well preserved in perfectly clear amber, in which, however, there is a flaw obstructing the view of some structures. When examined in an inclined ray of light the whole spiderling assumes the color of pure gold. The comb is plainly visible. The claws of one leg can be studied under high power and are of the same structure as in the type. I compared the specimen with the type and am satisfied of its identity.

GENUS *EOMYSMENA* PETRUNKEVITCH, 1942

Eomysmena succini Petrunkevitch

Figures 39-41, 67

Eomysmena succini PETRUNKEVITCH, 1942, A study of amber spiders, p. 286, pl. 36, figs. 341-346, pl. 67, fig. 606.

The type of this species is an immature male. A.M.N.H. No. 26263 is a mature female and is therefore the gynotype (figs. 39-41, 67). It is a complete specimen with clearly visible ventral surface and face. Although the abdomen is caved in, the spinnerets are perfectly visible on its concave surface. The view of the dorsal surface is spoiled by emulsion, but the outlines of the body may be seen. Since in the majority of Recent spiders immature males generally resemble females I see no objection to placing this female in the same species with the male. In the type the mouth parts and portion of the sternum are not visible, whereas in the present specimen they can be seen much better than is the case in most amber spiders. That is the reason why the figures given here were made at considerable magnification.

GYNOTYPE: Total length 1.9 mm. Clypeus strongly concave directly under the eyes, then convex and slanting, as high as the quadrangle. The latter is elevated on a joint tubercle and is slightly wider behind

than in front in ratio 10:9 and wider than long in ratio 10:8. Exact measurements of eyes are very difficult because the curvature of the eyes stands in direct continuation with the curvature of the tubercle. The latter is light yellow like the clypeus, though much darker toward its edges. The AME appear to be slightly larger than the PME, while the lateral eyes are still a little smaller. Each pair of laterals is on a common tubercle. A pair of bristles is present in the middle of the quadrangle and a single bristle under its anterior edge.

The chelicerae are more or less parallel, though slightly tapering toward their transverse margins, which are short and devoid of armature or scopulae. The ventral angle of the margins is so sharp that it has the appearance almost of a tooth, but by shifting the angle of observation one can see plainly that this effect is due to distortion of the image, a phenomenon only too common in amber specimens, and against which one has to be constantly on guard. A boss is wanting. The surface of the basal joint is yellow, virtually glabrous except for four or five very slender hairs situated each in a circular base. The fang has a very stout base, is attenuated suddenly, and is curved and pointed.

The maxillae (fig. 39) are protruding far beyond the chelicerae. The serrula is plainly visible and quite long. Viewed from below the maxillae appear strongly inclined over the lip, almost meeting in the middle line. There is a small tuft of hair at the end of the inner corner. The lip is trapezoidal, wider at base than long (fig. 41). The sternum is strongly convex, slightly longer than wide in ratio 24:21, clothed with very few, scattered hairs. The first coxae are wide apart; the fourth coxae are separated by less than their width.

The legs are stout, but the width of the patella cannot be measured, and the tibial

LEGS	FEMUR		PATELLA + TIBIA		METATARSUS	TARSUS	TOTAL
I	0.75		0.87		0.45	0.45	2.52
II	0.75		0.87		0.40	0.40	2.42
III	0.55		0.50		0.35	0.40	1.90
IV	0.80		0.92		0.47	0.50	2.69
	4	1	2	3			
Leg formula	2.8	2.6	2.5	2.0			

indices cannot be given. Spines are wanting, but the usual dorsal bristles are present on the patellae and tibiae. The comb is plainly visible on the left fourth tarsus and is composed of seven bristles. The claws are also plainly visible on all tarsi, but are in such a position that their finer structure cannot be ascertained. The third claw is bent at right angles and is smooth.

The abdomen is clothed with stiff bristles mostly directed backward, yet irregular in their distribution. The spinnerets are quite typical. The anterior pair is the stoutest. The colulus is plainly visible and well developed.

A remarkable feature of this specimen and one most unusual in amber spiders is the apparent preservation of the original colors. Some of the chitin is dark; other portions are light yellow or buff. The light color of the eye tubercle has already been mentioned and is a striking feature immediately attracting attention. The chelicerae are only slightly darker. The coxae and trochanters are light yellow. The sternum, on the other hand, is dark brown. The lip is dark brown with a yellow edge as are the maxillae. The legs are brown with still darker spots. The femur of the palp is yellow, but the rest of the palp is dark brown.

The condition of the ventral wall of the abdomen makes a study of the epigyne impossible.

FAMILY ARGIOPIDAE

Subfamily Araneinae

GENUS *EUSTALOIDES* PETRUNKEVITCH, 1942

Eustaloides setosus Petrunkevitch

Figures 42, 43, 70

Eustaloides setosus PETRUNKEVITCH, 1942, A study of amber spiders, p. 318, pl. 30, figs. 279-283, pl. 65, fig. 590.

Specimen A.M.N.H. No. 26264 is, as is the type, a mature male. It is a fairly well-preserved specimen and shows typical details of structure, but in addition shows the structure of the palpi better than does the type, which belongs to the British Museum. Figure 43 shows the basal apophysis of the cymbium, the haematodocha, and the sclerites of what is presumably the con-

ductor. When studied in a slightly inclined position the palp reveals the curved, sickle-like embolus shown in figure 42.

Subfamily Metinae

GENUS *ACROMETA* PETRUNKEVITCH, 1942

Acrometa cristata Petrunkevitch

Acrometa cristata PETRUNKEVITCH, 1942, A study of amber spiders, p. 324, pl. 9, figs. 72-82, pl. 55, fig. 516, pl. 59, figs. 541-546.

Specimen A.M.N.H. No. 26265 is a mature male. It is complete, but in rather poor amber full of imperfections. The palpi and all other important structures fully conform with the type and the other specimens that are in the British Museum.

GENUS *THERIDIOMETA* PETRUNKEVITCH, 1942

Theridiometa robusta Petrunkevitch

Theridiometa robusta PETRUNKEVITCH, 1942, A study of amber spiders, p. 335, pl. 69, fig. 621.

The type of this species is in the collection of Cornell University. It is a young spiderling.

Specimen A.M.N.H. No. 26266 presumably belongs to the same species. It is very poorly preserved, the only well visible structure being the spinnerets. The rest of the body is covered with white emulsion, making identification uncertain. The total length of the specimen is 1.75 mm.

BRANCH DIONYCHAE

FAMILY INCEPTORIDAE

GENUS *INCEPTOR* PETRUNKEVITCH, 1942

Inceptor dubius, new species

Figures 44-49, 74

HOLOTYPE: A.M.N.H. No. 26267. Total length 4.0 mm. Carapace 1.75 mm. long, 1.35 mm. wide between second and third coxae, 0.75 mm. wide in face view. A line-like thoracic groove is present at the place where the posterior declivity begins, a place so far back from the front that the groove is easily overlooked (fig. 45). The eye group (figs. 47, 48) is considerably narrower than the head. The four anterior eyes are equal and contiguous. The second row of eyes is wider than the first. Its eyes are also

equal, but a shade larger than those of the first row, and are evenly spaced. The laterals are separated by a fraction more than their radius. The quadrangle is distinctly wider behind than in front in ratio 11:9. The carapace is clothed with fine hair directed forward in a median band, but upward and inward on the sides.

The chelicerae are short, stout, conical, with the inner edges strongly divergent. A boss is wanting. In front the chelicerae are clothed with bristles. The fang is slender, gently curved, pointed, and about as long as the basal joint.

The ventral surface of the spider is heavily coated with emulsion, leaving only the posterior end of the sternum visible. The first coxae are apparently wide apart; the fourth coxae are contiguous.

parently they form a single row on metatarsi and tarsi. The distal tarsal trichobothrium is curved backward and is about as long as two-thirds of the tarsus.

Two claws, similar (fig. 46), long, and slender, strongly curved, armed with five or six teeth. Claw tufts wanting.

The epigyne (fig. 49) is plainly visible, but its structure is difficult to make out because the view is somewhat obstructed, partly by the fourth right metatarsus, partly by some white emulsion. It seems to consist of a central bar separating a pair of fossae. The bar is convex and much wider in front than behind. In the middle it has a projection on each side. On the right side of the bar (the spider's left) a black C-shaped structure is visible which may be a piece of an embolus broken off

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	1.35	1 85	0 95	0.75	4.90
II	1.25	1.65	0 90	0.75	4.55
III	1.35	1.35	0 90	0.75	4.35
IV	1.65	2 10	1 75	0.90	6.50
	4	1	2	3	
Leg formula	3.7	2.8	2.6	2.5	

SPINES: First leg: Femur dorsal 1-1-1, prolateral 0-0-1, retrolateral 0, ventral 0. Patella dorsal 1-1 small bristles, elsewhere 0. Tibia prolateral 1-1-0, ventral 1-1-0, elsewhere 0. Metatarsus prolateral 1-1, ventral 1-1, elsewhere 0. Second leg: Same as first. Third leg: Femur dorsal 1-1-1, prolateral 0-1-1, elsewhere 0. Patella dorsal 1-1 small bristles, elsewhere 0. Tibia dorsal 1-1-0, prolateral 1-1-0, retrolateral 1-1-0, ventral 2-2-0. Metatarsus dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2. Fourth leg: Same as third except femur prolateral 0-0-1, retrolateral 0-0-1, tibia ventral 2-2-2.

All tarsi lightly scopulate, the third and fourth pair so lightly that the scopula is scarcely noticeable. The first metatarsus is lightly scopulate in distal half, the second in distal third, the third and fourth not at all. The legs are clothed with simple hair, most of which is inclined forward, but some hairs are erect. The disposition of the trichobothria is difficult to ascertain. Ap-

parently they form a single row on metatarsi and tarsi. The distal tarsal trichobothrium is curved backward and is about as long as two-thirds of the tarsus.

The spinnerets are partly covered with emulsion. Only portions of the anterior and posterior pair are visible. Their terminal joints are hemispherical. The abdomen is clothed with short, stout hair, much longer in front and on the back.

The family Inceptoridae erected by me for a single genus and species, *Inceptor aculeatus*, is now enriched by this second species.

The two species may be distinguished as follows:

Chelicerae parallel, with boss. Posterior median eyes half as large as anterior median eyes.....*I. aculeatus*
Chelicerae conical, without boss. Posterior median eyes almost of the same size as anterior median eyes.....*I. dubius*

FAMILY EUSPARASSIDAE

Subfamily Eusparassinae

GENUS ADULATRIX PETRUNKEVITCH, 1942

Adulatrix rufa Petrunkevitch

Figures 50-55, 75

Adulatrix rufa PETRUNKEVITCH, 1942, A study of amber spiders, p. 364, pl. 29, figs. 267-272, pl. 62, fig. 570, pl. 63, fig. 577.

In "A study of amber spiders," I described two specimens under this species and referred a third one as presumably belonging to it. The American Museum has three specimens (A.M.N.H. Nos. 26268:1-26268:3) which I placed in this species. The first two are immature females, as are the type and paratype, belonging to the British Museum. A.M.N.H. No. 26268:3 is a mature male (figs. 50-55, 75). The similarity with the type is great, but there is a difference in the shape of the carapace. However, this difference may be sexual and is no greater than usually found in Recent spiders. I do not hesitate, therefore, to consider it as the androtype of the species. The first pair of legs, the third left leg, and the distal half of the left fourth leg are missing. A small insect obstructs the view of the eye group from above, but leaves it visible at a slight angle. The amber is imperfect, very dark, with many cracks and bubbles, but with only a trace of emulsion between the chelicerae. The important

is 0.75 mm. above the level of the sternum. From here on the carapace slopes in a very gentle curve forward and much more rapidly backward. The thoracic groove is longitudinal (fig. 50) but is difficult to see on account of a bubble which fills the inside of the spider. The eyes of the posterior row are equidistant, larger, and farther apart than those of the anterior row (fig. 53), so that the distinctly procurved second row is wider than the first row. In face view both rows are downcurved, but when viewed from above the first row is straight. The quadrangle is much wider behind than in front and but a fraction less than twice as wide as long. The clypeus is a little higher than the diameter of the anterior median eyes. The carapace is sparsely clothed with short, recumbent hair.

The chelicerae are with diverging inner edges, without boss, with a scopula of fairly stout bristles on the promargin. The fang is stout, short, and evenly curved.

The maxillae are parallel, but as their shape is rhomboidal, their distal edges appear strongly diverging. The lip does not reach their middle (fig. 52). The sternum is flat, widely truncated in front, pointed behind, longer than wide in ratio 27:22, very sparsely clothed with short hair. The first coxae are wide apart; the fourth coxae are subcontiguous. The trochanters are notched.

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
II	2.60	3.30	2.30	1.80	10.00
III	2.40	2.80	2.30	0.85	8.35
IV	3.85	4.15	ca. 2.50	1.85	12.35
	4	2	1	3	
Probable leg formula	5.1	4.2	?	3.5	

features of the palpi are visible. The legs are laterigrade and can be measured.

Total length 5.6 mm. Carapace 2.40 mm. long, 2.05 mm. wide between second and third coxae. The sides of the carapace are rounded and on reaching the level of the palpi change suddenly from being convex to concave so that the head in this region is only 0.87 mm. wide and its sides from here on are almost parallel. The face is 0.72 mm. wide, and the highest point of the carapace, situated in the region of the thoracic groove,

The fourth metatarsus is broken; the length given is only approximate, but is very close to the correct one.

SPINES: Second leg: Femur dorsal 1-1-0, prolateral 0-1-1 (very small) elsewhere 0. Patella 0. Tibia dorsal 0, prolateral 0-1-1, retrolateral 0-1-1, ventral 2-1r-1p-2. Metatarsus prolateral 0-1-0, retrolateral 0-1-0, elsewhere 0. Third leg: Femur dorsal 1-1-1, prolateral 0-1-1, retrolateral 0-1-1, ventral 0. Patella 0. Tibia dorsal 1-1-0, prolateral 0-1-1, retrolateral 0-1-1, ventral

2-2-2-2. Metatarsus prolateral 1-1-1, retrolateral 1-1-1, elsewhere 0. On account of the position of the spider the spines of the fourth leg cannot be placed.

The second tarsus is lightly scopulate, but the third and fourth tarsi have no scopula.

Two claws, similar, strongly curved, stout, with three teeth (fig. 51). Tenent hairs wanting, but a few hairs between the claws and at the end of the tarsus form a false claw tuft. Trichobothria numerous but difficult to see. They are present on tibia, metatarsus, and tarsus. The legs are clothed with simple hair which is slender and recumbent on the femur and tibia, but then begins to be stouter and stands at an angle especially on tarsus. Some short, erect hairs are present on tarsi.

The abdomen is fairly cylindrical, evenly rounded at both ends, 2.9 mm. long, 1.4 mm. wide, clothed with simple, recumbent hair. The spinnerets are not sufficiently visible to ascertain their structure.

The palp (figs. 54, 55) is distinctly spinose. One can see the long, stout spines on the femur, patella, and tibia. On the femur there is only one dorsal spine a little beyond middle. On the patella there are the usual 1-1 dorsal spines and of these the proximal one is smaller and more slender. There is also one prolateral, but no retrolateral or ventral spines. On the tibia there are 2-1p dorsal spines, 1-1 prolateral and 1-0 retrolateral spines, but no ventral ones. The tibia has an apical retrolateral apophysis shown in figure 55. The copulatory apparatus can be seen only with difficulty on account of the position of the palpi. The haematodocha is extended, and a dark sclerite is visible at its end. This may be either a conductor or the embolus (figure 54).

GENUS ZACHRIA L. KOCH, 1875

Zachria peculiata, new species

Figures 56-60, 76

The holotype (A.M.N.H. No. 26269) is a well-preserved specimen in clear amber of peculiar shape and with two planes of stress, one of which is dark in color. There is also some white emulsion on the ventral surface, hiding from view the mouth parts and the spinnerets. The specimen is an immature one, presumably of the female sex.

Total length 3.68 mm. Carapace 1.70 mm. long, 1.45 mm. wide between second and third coxae, 0.75 mm. wide in face view. It is highest in the region of the thoracic groove, sloping from here forward gently and backward more rapidly. On the whole the carapace is rather flat. Eight eyes in two rows as usual for the genus (figs. 59 and 60). The anterior row is gently recurved, the posterior row straight. Ratio of eyes AME:ALE:PME:PLE = 4:7:4:4.5. The anterior median eyes are separated from each other by about their diameter and by a little less than their diameter but more than their radius from the anterior lateral eyes. The lateral eyes are far apart. The posterior eyes are equidistant, separated by almost two diameters. The quadrangle is wider behind than in front and as wide as long. Clypeus slightly higher than the diameter of the anterior median eyes. The thoracic groove has the shape of a deep depression widening behind. The head is on the same level with the thorax, is very wide and clearly delimited by cephalothoracic sulci. The carapace is clothed with dark brown, bristle-like hair. No recumbent hair is visible.

In the position which the spider occupies in the amber its legs do not produce the appearance of being laterigrade. as they

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	1.50	2.10	1.40	0.70	5.70
II	1.80	2.30	1.40	0.70	6.20
III	1.50	1.50	1.00	0.70	4.70
IV	1.60	1.60	1.25	0.70	5.15
	2	1	4	3	
Leg formula	3.7	3.3	3.0	2.8	

Width of first patella 0.257 mm. First tibial index 12

Width of second patella 0.257 mm. Second tibial index 11

Width of third patella 0.250 mm. Third tibial index 15

certainly must have been. The third left leg is directed backward, the third right leg forward; both fourth legs are directed backward. The first right leg was autotomized in life. The second right leg was torn off when the spider still struggled in the sticky resin and lies now in front of the third leg considerably below the spider. Coagulated blood still forms a plug in the trochanter. The first and the second left legs, although directed forward, are both distinctly laterigrade while the third and fourth left legs are in a distinctly prograde position.

The width of the fourth patella cannot be measured because the legs were polished off at the knee.

SPINES: First leg: Femur dorsal 0-1-1, prolateral 0-1-0, elsewhere 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-1-0, prolateral 0-1-0, retrolateral 0-1-0, ventral 2-2-2, the distal pair small. Metatarsus dorsal 0, prolateral 1-1-0, retrolateral 0-1-0, ventral 2-2-0. Second leg: Same as first except femur prolateral 0. Third leg: Femur dorsal 0-1-1, elsewhere 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-0-1, elsewhere 0. Metatarsus prolateral 0-1-0, ventral 2-2-0, elsewhere 0. Fourth leg: Same as third except metatarsus ventral 2-2-2.

All tarsi dorsally distinctly convex (fig. 57). Scopula on all four tarsi, but rather scanty and formed by stiff, short hair. Trichobothria numerous, but difficult to see. Claw tufts well developed, formed by flattened hairs. Two claws, similar, with a single tooth each (fig. 58). The legs are clothed with simple hair, some of it stouter and more inclined.

The ventral view of the spider is badly obstructed by emulsion and imperfections of the amber. However, it appears certain that the first coxae are far apart and the fourth coxae are separated by about one-half of their width. The palp has a claw with a single tooth. The abdomen is ellipsoidal, flattened above; its back is clothed sparsely with stiff and long, bristling hair, while the venter is more densely clothed

with much shorter hair. The spinnerets are not visible.

This is the first representative of the genus *Zachria* which had been established for a species living in Australia. The genus is easily separated from *Adulatrix* by the order of legs.

FAMILY THOMISIDAE

Subfamily Thomisinae (= Misumeninae)

GENUS MISUMENA LATREILLE, 1804

Misumena samlandica Petrunkevitch

Misumena samlandica PETRUNKEVITCH, 1942, A study of amber spiders, p. 375, pl. 40, fig. 379, pl. 68, fig. 615.

Both the generic and specific affiliations of this specimen (A.M.N.H. 26270) are not quite certain. Although the amber itself, in which it is embedded, is quite clear, the spider is so heavily coated with white emulsion that careful study and measurement are impossible. The first right and both second legs are missing. The disposition of the eyes in two rows is apparent; the eyes are visible through the emulsion as orange discs with hazy edges. The first left leg is bent to the right in such a manner that it hides from view almost the entire carapace except for a portion of its left edge. The chelicerae are parallel, the fangs are slender, but the armature is not visible. The stiff bristles with which the abdomen is clothed show clearly through the emulsion. The ventral surface of the spider is much better visible. The sternum is heart-shaped. The first coxae are wide apart, as are the second coxae; the fourth coxae are separated by their width. On the first left tarsus in one certain position one of the claws is visible and shows several slender teeth. The legs are laterigrade, and the first leg is considerably longer than the fourth. Spines are wanting. The hair is simple. A swollen area is visible in the place where the epigyne should be.

I assigned the specimen to this species on comparing it with the type, which it resembles in outward appearance.

FAMILY SALTICIDAE

Division Unidentati

Subfamily Gorgopidinae

GENUS GORGOPIS MENGE, 1854

Gorgopsis frenata (Koch and Berendt)

Phidippus frenatus KOCH AND BERENDT, 1854, Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt, p. 88, pl. 9, figs. 83, 84.

Gorgopsis frenata MENGE in Koch and Berendt, 1854, *op. cit.*, footnote, p. 93.

Gorgopsis frenata, PETRUNKEVITCH, 1942, A study of amber spiders, p. 408, pl. 2, figs. 8-11, pl. 3, figs. 20-25, pl. 4, figs. 27, 28, pl. 6, fig. 50; photographs, figs. 517, 519, 520, 521.

A mature male (A.M.N.H. No. 26271). The amber is full of bubbles, but the important characters are clearly visible. Both palpi show plainly the characteristically hooked tibial apophysis. The second pair of legs are missing. The species seems to have been common in Baltic amber.

Division Pluridentati

Subfamily Boethinae

GENUS EOLINUS PETRUNKEVITCH, 1942

Eolinus succineus Petrunkevitch

Eolinus succineus PETRUNKEVITCH, 1942, A study of amber spiders, p. 424, pl. 5, figs. 37-44, pl. 56, figs. 524, 525.

The specimen (A.M.N.H. No. 26272), a fairly well-preserved mature male, is typical. Of special interest is the excellent preservation of the hair on the body and on the legs. It is light in color, of the simple type, and so dense that the spider has a distinctly "hairy" appearance. Scales are completely wanting.

BRANCH QUADROSTIATAE

FAMILY OONOPIDAE

GENUS ORCHESTINA SIMON, 1892

Orchestina baltica Petrunkevitch

Orchestina baltica PETRUNKEVITCH, 1942, A study of amber spiders, p. 444, pl. 6, figs. 52-54, pl. 7, figs. 55-56, pl. 25, figs. 233-237, pl. 59, figs. 547-550, pl. 69, fig. 626.

Specimen A.M.N.H. No. 26273 is a well-preserved female, typical in structure, and

adding nothing new to the knowledge of this common species.

FAMILY ANYPHAENIDAE

GENUS ANYPHAENA SUNDEVALL, 1833

Anyphaena fuscata Koch and Berendt

Figures 61-66, 68

Anyphaena fuscata KOCH AND BERENDT, 1854, Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt, p. 64, pl. 6, fig. 56.

The hypotype (A.M.N.H. No. 26274) is a well-preserved specimen, in clear amber except for the presence of two parallel planes of stress reflecting light and making the examination from certain angles difficult. Except for the fourth pair, which are straight, the legs are bent under and obstruct to a great extent the view of the mouth parts and sternum. The venter of the abdomen shows clearly the genital fold, the spinnerets, and the tracheal spiracle, making the identification of the genus quite certain. This character was not mentioned by Koch because its value was not realized at that time. His specimen was a mature male. Menge mentions two other specimens of the same species in his private collection, one of them a male, the other a female. The genus *Anyphaena* was created by Sundevall for a Recent species, *A. accentuata* (Walckenaer), and the latter was the only known species at the time when Koch described *A. fuscata*. Since that time several Recent European species have been described. The genus is represented also in India, Japan, and in North, Central, and South America. On account of the number of species found in America the genus may be considered to be preëminently American. The specific affiliation of the Baltic amber specimen in question cannot be regarded as absolutely certain until the present specimen has been compared with the type. Koch's description and figure are inadequate for the purpose. Nevertheless the creation of a new species for our specimen would be quite out of place.

Specimen A.M.N.H. No. 26274 is an immature female. Total length including spinnerets 4.16 mm. Carapace 1.25 mm. long, 0.90 mm. wide, 0.50 mm. high. Abdo-

men without spinnerets 1.85 mm. long, 1.10 mm. wide. Sternum 0.62 mm. long, 0.50 mm. wide. Lip 0.15 mm. long, 0.20 mm. wide at base.

Tibia ventral 1p-1p-0, elsewhere 0. Metatarsus dorsal 0-1, prolateral 0-1, elsewhere 0. Second leg: Same as first. Third leg: Femur dorsal 1-1-1, the distal pair small,

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	0 90	1 10	0 52	0 37	2 89
II	0 85	1.02	0 52	0 37	2 76
III	0 85	0.85	0 60	0 35	2 65
IV	1.17	1.17	1.05	0.47	3 66
Leg formula	4 1 2 3				
	2.9 2.3 2.2 2.1				

Width of first patella 0.15 mm. First tibial index 14

Width of fourth patella 0.15 mm. Fourth tibial index 13

Carapace of the shape shown in figure 65, with a longitudinal thoracic groove situated far back. In profile (fig. 61) the carapace is highest at the groove, sloping in a gentle curve forward and steeply backward. The eyes are in two rows (fig. 62). The first row is so much shorter than the second row that the posterior lateral eyes form an even curve with it. Ratio of eyes AME:ALE:PME:PLE = 4.5:6:5:5. The anterior median eyes are separated almost by their diameter, but from the anterior lateral eyes by about their radius. The eyes of the posterior row are equidistant, separated by a little less than two of their diameters. The quadrangle is wider behind than in front in ratio 19:14 and wider than long by about the same ratio. The second row is distinctly procurved. The clypeus is equal to three-quarters of the diameter of the anterior median eyes.

The chelicerae are visible, but their structure cannot be ascertained. The maxillae have parallel sides. They are considerably longer than the lip, are transversely truncated at the end and slightly inclined toward each other. The sternum is truncated in front, evenly rounded on the sides, pointed behind, more or less oval, distinctly convex, glabrous. The first coxae are separated by more than the width of the lip; the fourth coxae are subcontiguous.

SPINES: First leg: Femur dorsal 1-1-1, prolateral 0-0-1, elsewhere 0. Patella 0.

prolateral 0-0-1, elsewhere 0. Patella dorsal 1-1 very small spines, elsewhere 0. Tibia dorsal 0-1, prolateral 1-1, elsewhere 0. Metatarsus dorsal 1-1-1, 0-1-0, retrolateral 1-0-1, ventral 1-1-0. Fourth leg: Same as third, except patella dorsal 0-1, tibia ventral 0-1-0, metatarsus dorsal 1-0-1, prolateral 1-1-1, ventral 1-0-1.

Two claws, similar, with five or six teeth (fig. 64), of equal length. Claw tufts well developed, composed of a few flattened hairs which protrude beyond the claws, making the examination of the latter troublesome. Scopulae wanting on all legs. Hair simple and scanty. Trichobothria not visible.

Abdomen of an elongated oval shape, sparsely clothed with short, simple hair. The genital fold is gently procurved. The tracheal spiracle (fig. 63) is plainly visible and is situated nearer to the genital fold than to the spinnerets. The spinnerets (fig. 66) are slender, cylindrical. The anterior pair are the stoutest and are almost contiguous at base. Their terminal joint is rounded and provided with several spinning tubes. The median pair are more slender and shorter than the anterior pair. The posterior pair are the longest and widely separated at base. Their terminal joint is rounded, but somewhat longer than the terminal joint of the anterior pair, and has five spinning tubes. A colulus is wanting. The anal tubercle is distinctly two-jointed.

REMARKS CONCERNING *ARGYRONETA ANTIQUA* HEYDEN

C. von Heyden described (1859-1861, vol. 8) two fossil spiders from the Tertiary Brown Coal of Rott in the Siebengebirge. One of these spiders he named *Argyroneta antiqua*. The eyes were not preserved; the segmentation of the legs is not visible, nor is the structure of the palpi, which were recognized as being of the male sex, sufficiently clear for description. Heyden's figure 12 of the complete spider is of no more help, showing no detail. Heyden states that the generic affiliation of the fossil is very doubtful and adds that he placed it in the genus *Argyroneta* because of its general habitus. He gives the relative

are preserved sufficiently well for this purpose.

The specimen is figured in our figure 80. Its total length with the chelicerae is 9.75 mm. The carapace is 3.36 mm. long, 2.80 mm. wide, more or less ellipsoidal, flat, without a trace of eyes. No thoracic groove is visible, but there is a median band of hair occupying two-thirds of the length of the carapace and a pair of posterior bands converging on the rear end of the median band. It is probable that a thoracic groove, if it existed, was situated at the meeting of the three bands of hair. No other hair can be seen on the carapace.

LEGS	FEMUR	PATELLA + TIBIA	METATARSUS	TARSUS	TOTAL
I	3 15	—	—	—	?
II	2 45	2 80	2 10	0 84	8 19
III	2 45	2 59	1 75	0 84	7 63
IV	2.80	3 71	2 59	1 75	10 85

length of the legs in German lines as follows: first leg $3\frac{2}{3}$, second 3, third and fourth $2\frac{1}{2}$. This means that the order of legs, if the measurements were correct, is 1234. The order of legs in the Recent *Argyroneta aquatica* is 1423. The difference in the order of legs makes it certain that Heyden's specimen was not an *Argyroneta*.

The American Museum of Natural History has a fossil spider (A.M.N.H. No. 26275) from the same locality as Heyden's specimen and labeled as such. It is not clear who identified it. It is about twice as long as Heyden's specimen. Except for the femur, the first pair of legs is missing. But judging by the relative length of the femora the assumption is warranted that the order of legs is 1423 and therefore the same as in *Argyroneta aquatica* and different from that of Heyden's specimen. Unfortunately the important characters of the American Museum specimen are not sufficiently well preserved to permit its identification from the point of view of modern arachnology. Personally I am inclined to refer it to the family Agalenidae, but plumose hair so characteristic of that family is wanting. It would be futile to give it a new name since neither its generic nor its specific characters

The legs are clothed with simple hair and have numerous spines, the distribution of which cannot be ascertained because of the flattened condition of the spider. Claw tufts are wanting, and one would naturally expect the spider to have three claws, but a third claw is not visible. The upper two claws are unfortunately broken and incomplete on all legs. One claw, the end of which is missing, is present on the third right leg and shows six long teeth. The mate of this claw is also broken. Both claws are stout and bent. Two broken claws can be seen on the second right leg and a piece of a claw on the fourth right leg. The chelicerae are very stout, parallel, with a scapula of fairly long hair. The fangs are short, directed transversely.

The abdomen is neatly ellipsoidal, 4.90 mm. long, 3.36 mm. wide, slightly overlapping the carapace. It is evenly rounded at both ends. Its dark brown color is due to foreign matter with which it is covered. Where this layer is chipped off the underlying surface shows the same buff color as the rest of the spider and on such exposed areas one sees plainly the short, simple, brown hair with which the abdomen is clothed. Only one pair of spinnerets is visible. They are short and cone-shaped.

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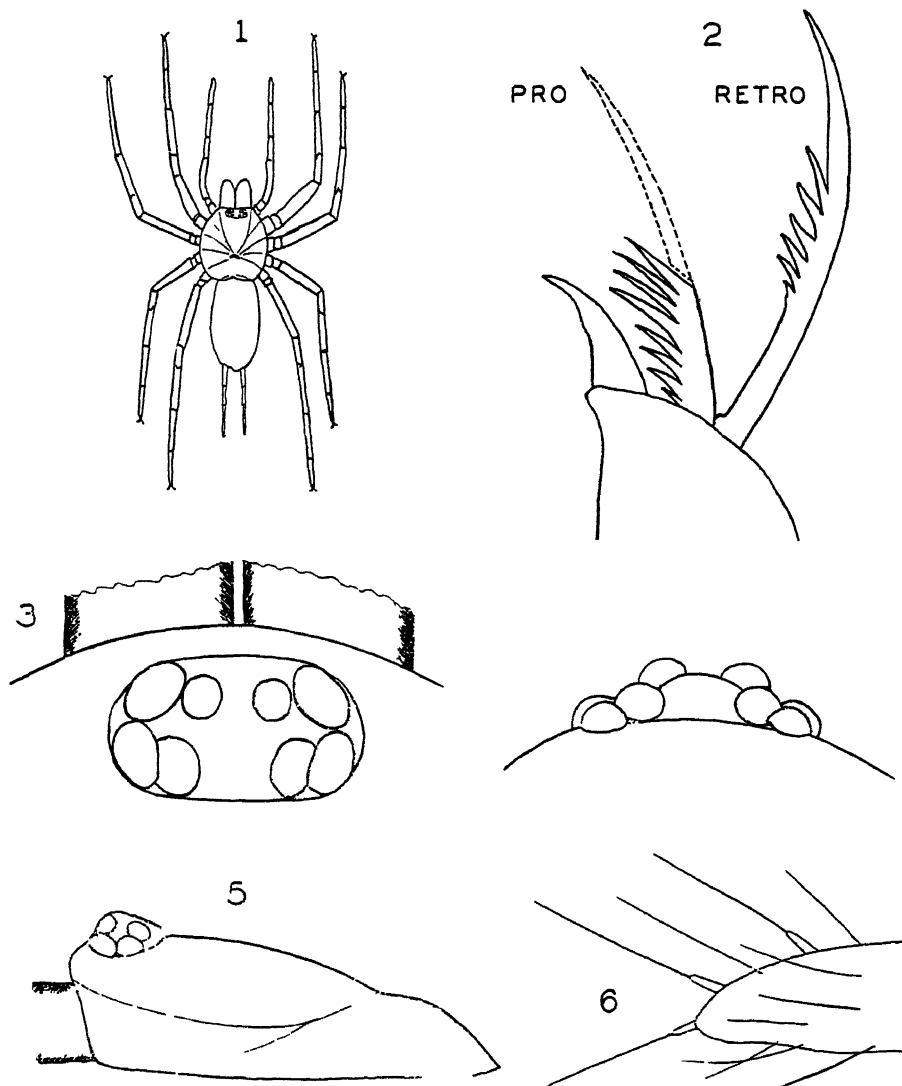


Fig. 1. *Clostes priscus* Menge, A.M.N.H. No. 26254, dorsal view of spider with legs drawn in their proper position. $\times 5.5$.

Fig. 2. Idem, claws of fourth right leg. $\times 250$.

Fig. 3. Idem, eye group viewed from above. $\times 60$. Only base of chelicerae shown.

Fig. 4. Idem, eye group viewed from behind. $\times 60$.

Fig. 5. Idem, carapace viewed from the left side. $\times 35$.

Fig. 6. Idem, end of a spinneret showing common hair and three spinning tubes. $\times 125$.

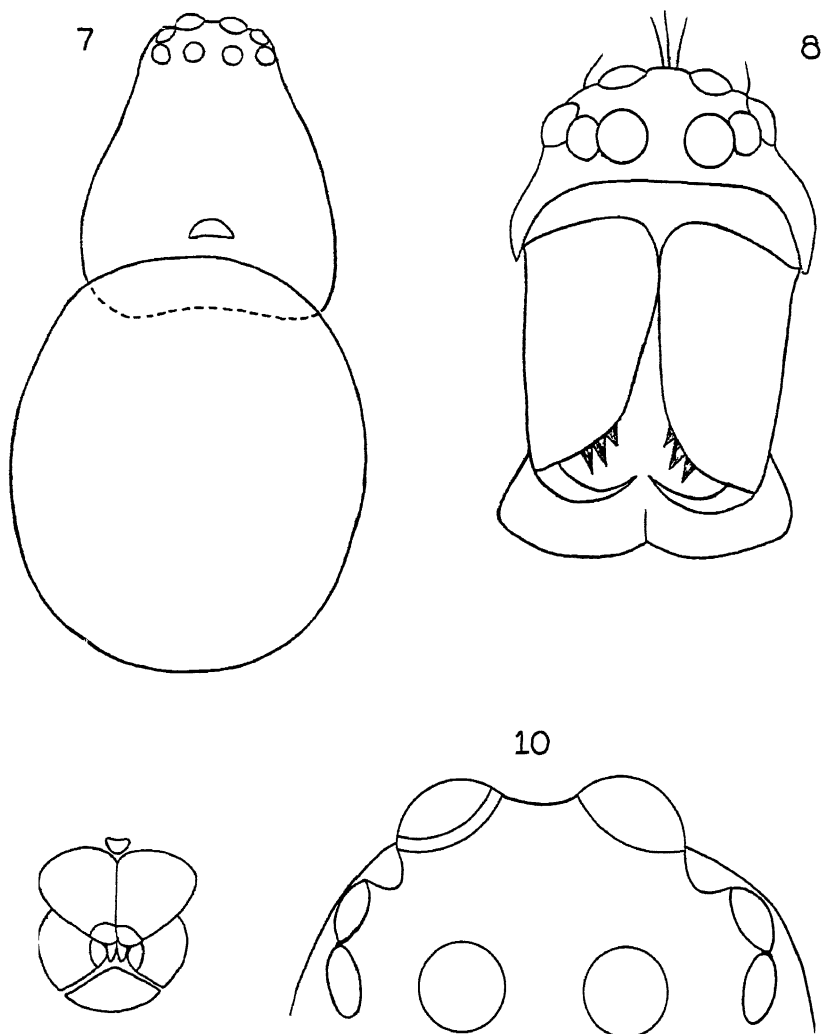


Fig. 7. *Egonatium robustum*, new species, holotype, A.M.N.H. No. 26255, dorsal view of spider with legs omitted. $\times 30$.
 Fig. 8. Idem, front view of face. $\times 60$. Below the fangs the outline of the maxillae is visible.
 Fig. 9. Idem, spinnerets, colulus, and tracheal spiracle. $\times 125$.
 Fig. 10. Idem, eye group viewed from above. $\times 125$.

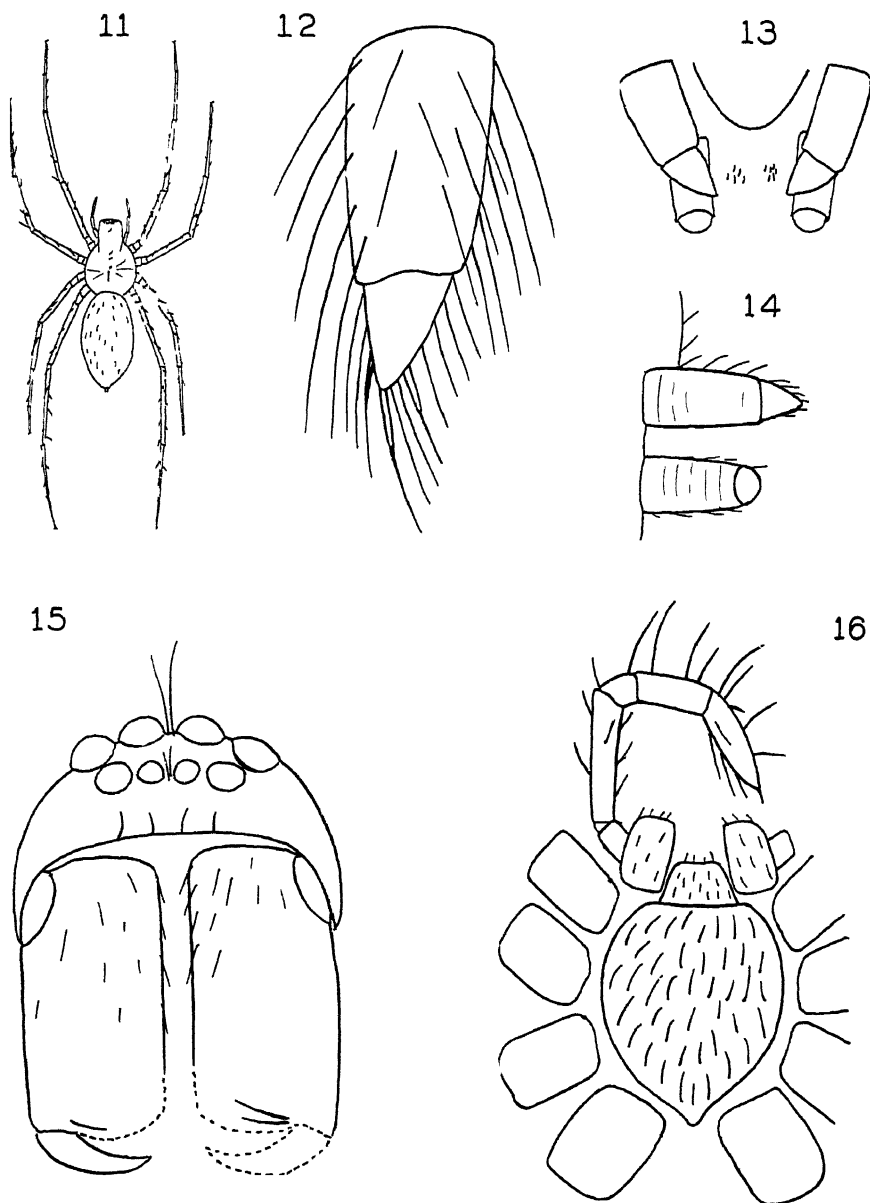


Fig. 11. *Eocryphoea gracilipes* (Koch and Berendt), hypotype, A.M.N.H. No. 26256, dorsal view of spider with legs drawn in their proper position. $\times 5.5$.

Fig. 12. Idem, right posterior spinneret with three spinning tubes on terminal joint. $\times 125$.

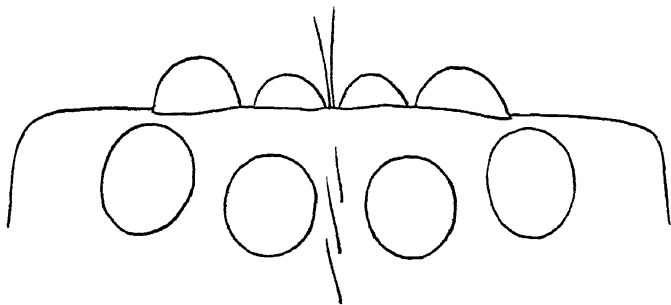
Fig. 13. Idem, spinnerets viewed from below. $\times 60$. Of the median spinnerets only the hairs at their ends are visible.

Fig. 14. Idem, spinnerets viewed from the left side. $\times 60$. The posterior spinneret is above the anterior one.

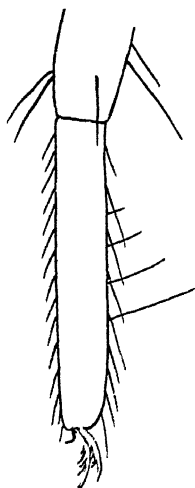
Fig. 15. Idem, front view of face. $\times 60$.

Fig. 16. Idem, ventral view of sternum and coxae. $\times 30$. Only one palp is shown.

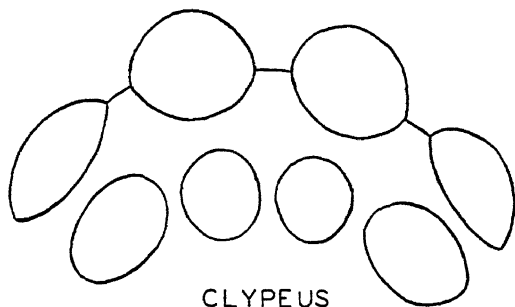
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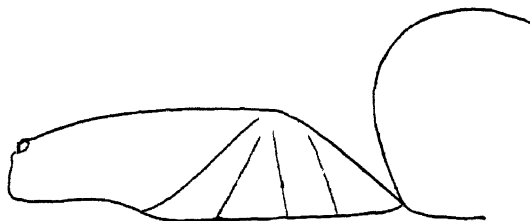


18



CLYPEUS

19



21

Fig. 17. *Eocryphoea gracilipes* (Koch and Berendt), hypotype, A.M.N.H. No. 26256, eye group viewed from above. $\times 125$.

Fig. 18. Idem, eye group viewed from in front. $\times 125$.

Fig. 19. Idem, carapace viewed from the left side. $\times 30$. All appendages omitted from the drawing, and of the abdomen only the anterior end shown.

Fig. 20. Idem, third left tarsus. $\times 60$. Notice the four trichobothria increasing in length distally.

Fig. 21. Idem, retroclaw and third claw of the fourth left tarsus. $\times 200$.

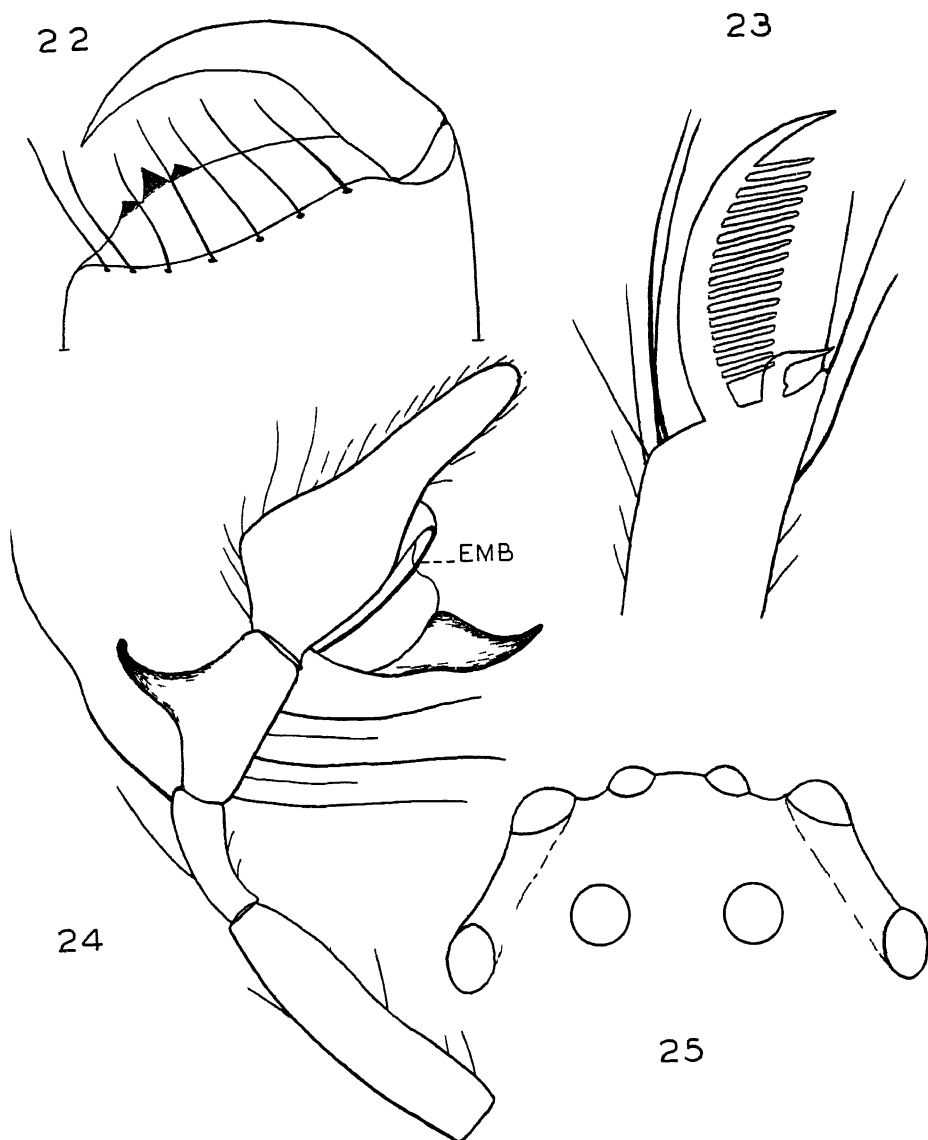
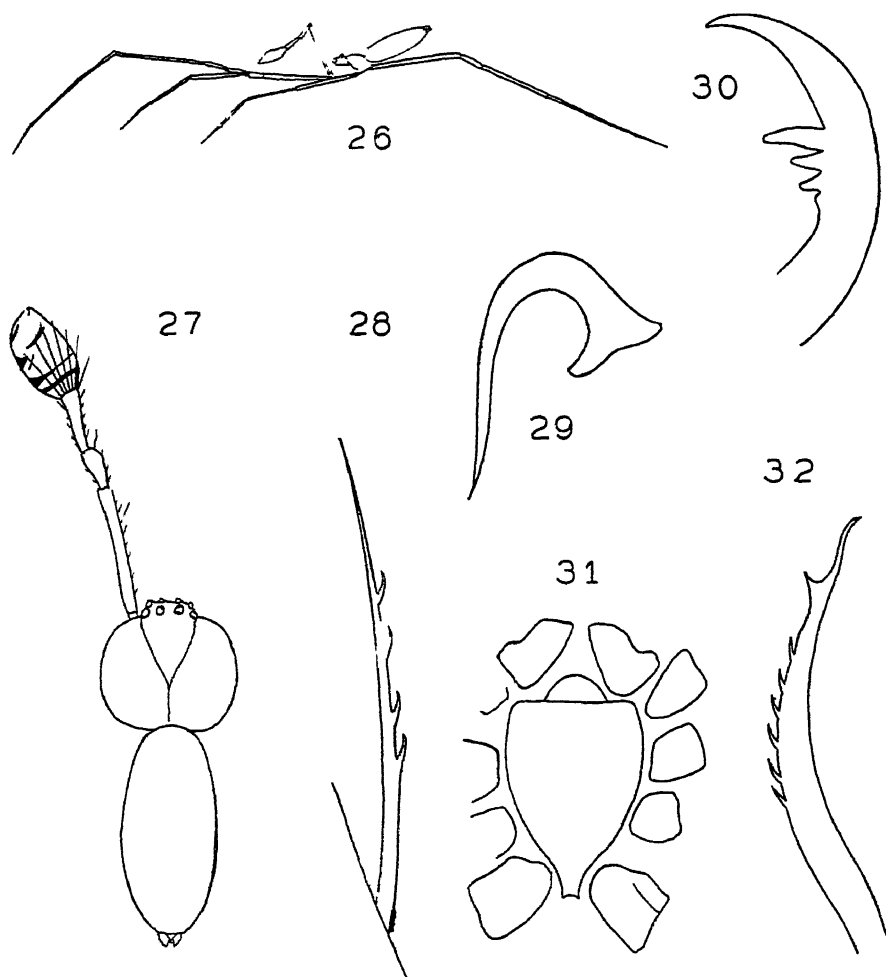


Fig. 22. *Insecutor aculeatus* Petrunkevitch, A.M.N.H. No. 26257:1, end of right chelicera, showing three retromarginal teeth and promarginal bristles. $\times 125$.

Fig. 23. *Insecutor mandibulatus* Petrunkevitch, androtype, A.M.N.H. No. 26258:2, proclaw and third claw of the second left leg. $\times 125$.

Fig. 24. Idem, prolateral view of left palp. $\times 30$.

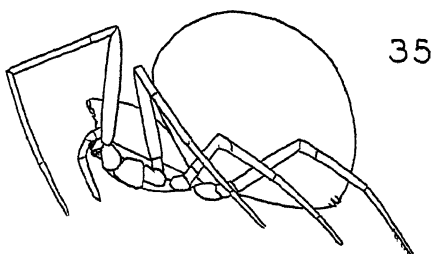
Fig. 25. Idem, eye group viewed from above. $\times 60$.



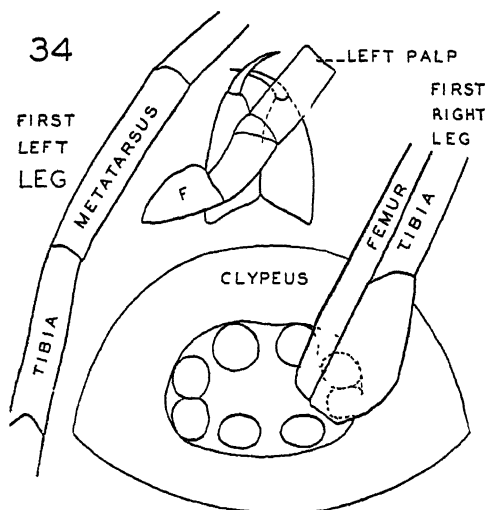
- Fig. 26. *Flegia longimana* Koch and Berendt, A.M.N.H. No. 26259, view of spider from the left side. $\times 5.5$. The legs of the right side are omitted from the drawing.
- Fig. 27. Idem, dorsal view of spider. $\times 15$. Of the appendages only the left palp is shown.
- Fig. 28. Idem, one of the 10 bristles of the comb of the fourth tarsus. $\times 400$.
- Fig. 29. Idem, third claw of the first left leg. $\times 800$.
- Fig. 30. Idem, one of the upper claws of the first left leg. $\times 800$.
- Fig. 31. Idem, sternum, coxae, maxillae, and lip. $\times 30$.
- Fig. 32. Idem, one of the two spurious claws of the first leg. $\times 800$.



33



35



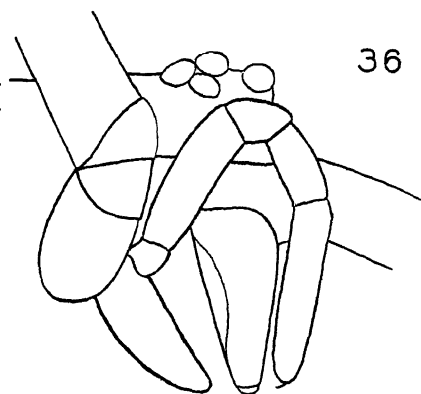
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FIRST
LEFT
LEG

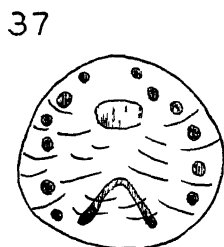
LEFT PALP

FIRST
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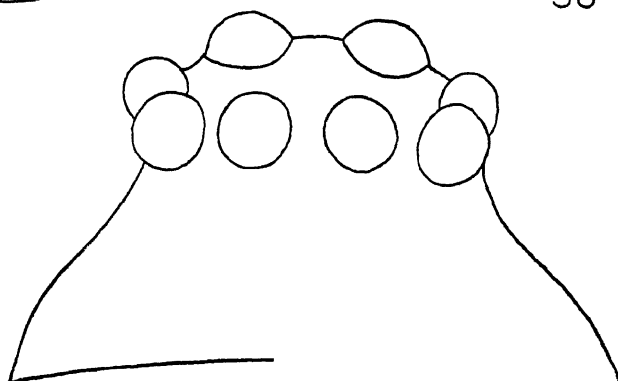
CLYPEUS

FEMUR
TIBIA

36



37



38

- Fig. 33. *Eodipoena oculata* Petrunkevitch, A.M.N.H. No. 26260, dorsal view of carapace. $\times 30$.
 Fig. 34. Idem, view of the face with the appendages in position. $\times 65$.
 Fig. 35. *Eodipoena baltica*, new species, holotype, A.M.N.H. No. 26261, view of spider from the left side with legs of the right side omitted. $\times 15$.
 Fig. 36. Idem, eye group and mouth parts viewed from the right side. $\times 65$.
 Fig. 37. Idem, epigyne. $\times 65$.
 Fig. 38. Idem, face view of eye group. $\times 125$.

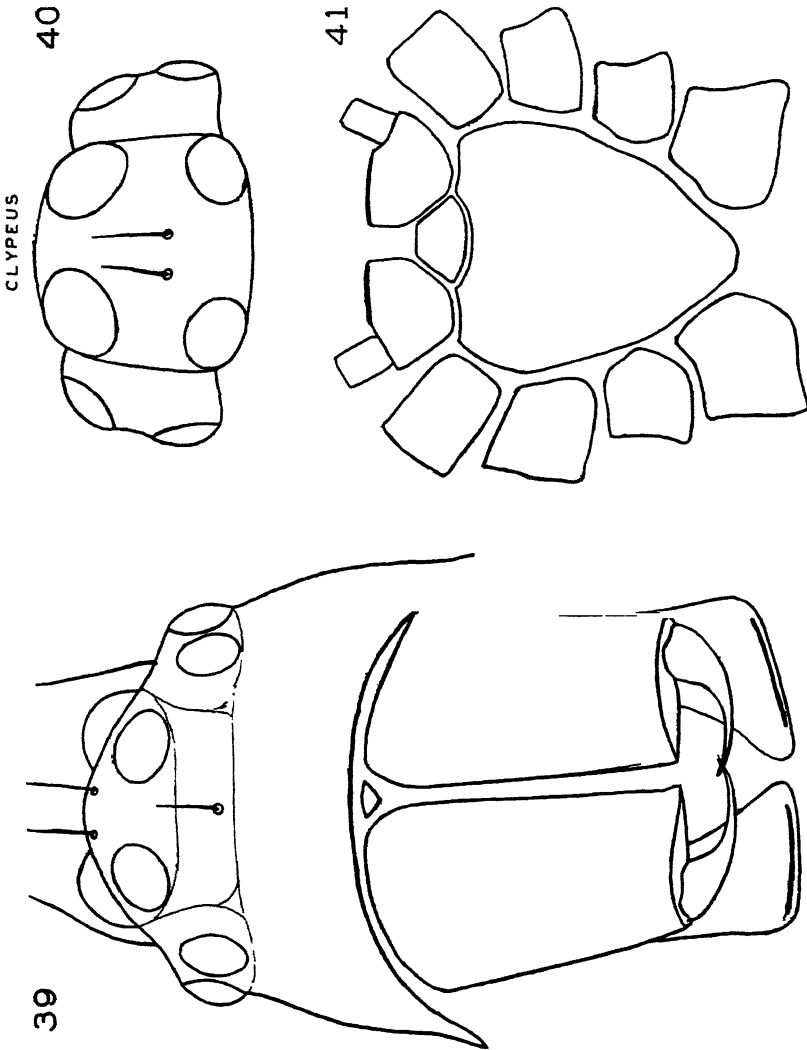


Fig. 39. *Eomyzomena succini* Petrunkevitch, gynotype, A.M.N.II. No. 26263, face view of spider. $\times 125$.
 Below the fangs the maxillae with the serrula are visible.
 Fig. 40. Idem, dorsal view of eye group. $\times 125$.
 Fig. 41. Idem, sternum, maxillae, lip, and coxae. $\times 60$. The serrula occupies the anterior edge of the maxilla and appears as a heavy black line.

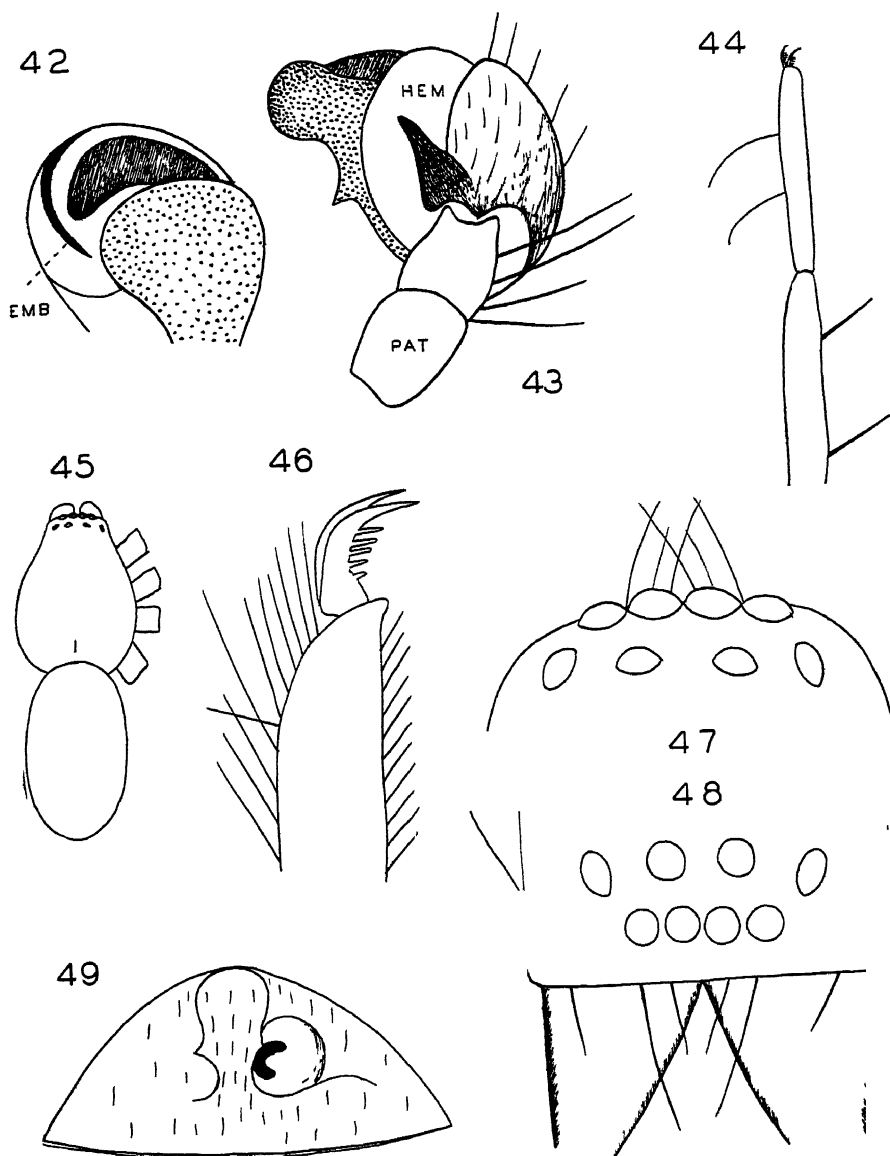


Fig. 42. *Eustaloides setosus* Petrunkevitch, A.M.N.H. No. 26264, end of left palp viewed from below to show embolus. $\times 125$.

Fig. 43. Retrolateral view of left palp. $\times 60$.

Fig. 44. *Inceptor dubius*, new species, holotype, A.M.N.H. No. 26267, metatarsus and tarsus of first right leg. $\times 30$.

Fig. 45. *Idem*, dorsal view of spider with legs omitted. $\times 11$. Notice the position of the thoracic groove.

Fig. 46. *Idem*, claws of first tarsus. $\times 125$.

Fig. 47. *Idem*, eye group viewed from above. $\times 60$.

Fig. 48. *Idem*, eye group viewed from in front. $\times 60$.

Fig. 49. *Idem*, epigyne. $\times 60$.

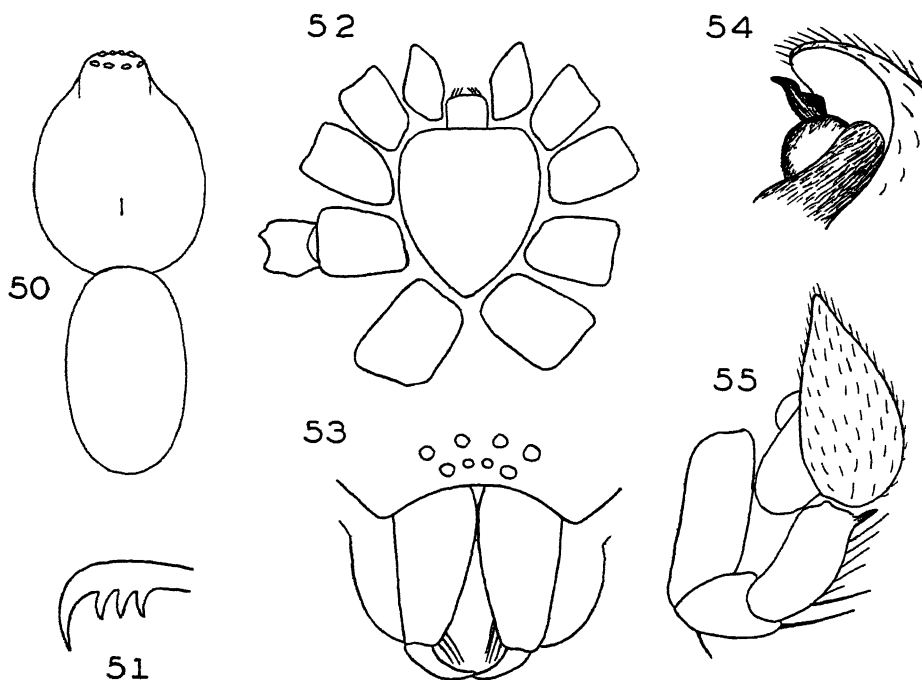


Fig. 50. *Adulatrix rufa* Petrunkevitch, androtype, A.M.N.H. No. 26268:3, dorsal view of spider with legs omitted. $\times 11$.

Fig. 51. Idem, retroclaw of second right leg. $\times 200$.

Fig. 52. Idem, sternum, maxillae, lip, and coxae. $\times 15$.

Fig. 53. Idem, face viewed from in front. $\times 30$. The outer edges of the maxillae are plainly visible.

Fig. 54. Idem, end of left palp, retrolateral view. $\times 30$.

Fig. 55. Idem, prolateral view of the right palp. $\times 30$.

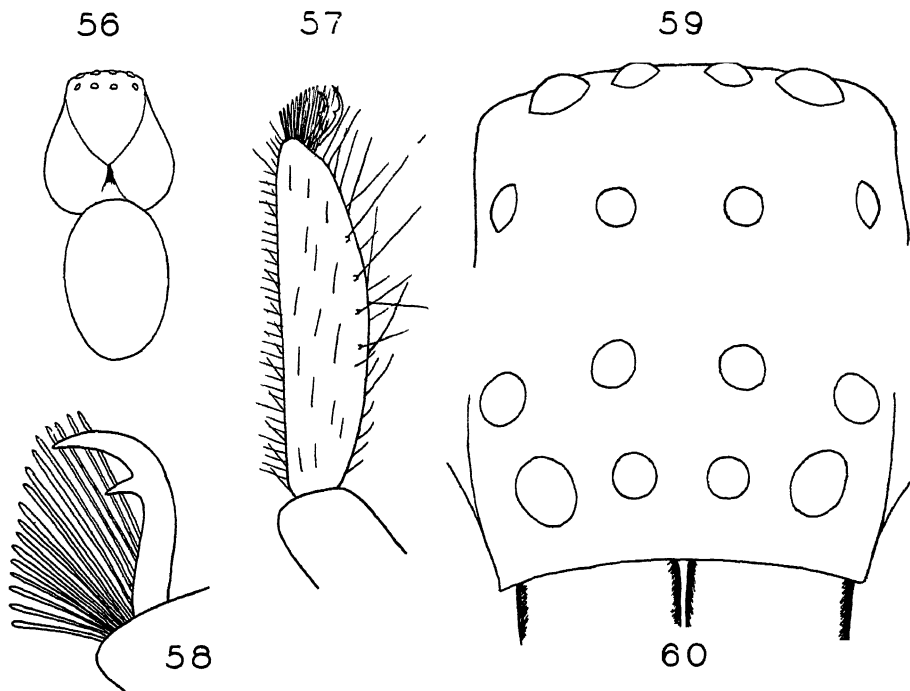


Fig. 56. *Zachria peculiata*, new species, holotype, A.M.N.H. No 26269, dorsal view of spider with legs omitted. $\times 11$.

Fig. 57. Idem, prolateral view of fourth right tarsus $\times 60$.

Fig. 58. Idem, proclaw and claw tufts of fourth right tarsus. $\times 200$.

Fig. 59. Idem, eye group viewed from above. $\times 60$.

Fig. 60. Idem, eye group viewed from in front. $\times 60$.

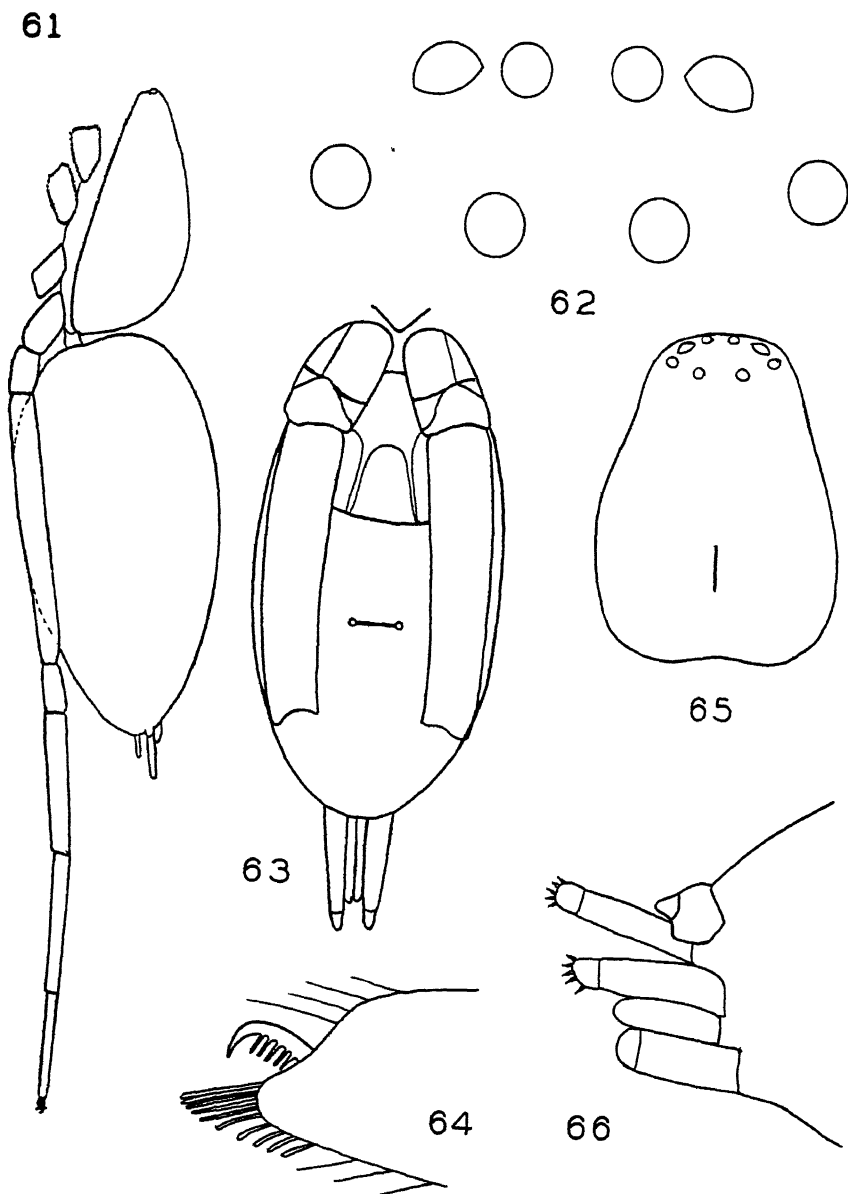


Fig. 61. *Anyphaena fuscata* Koch and Berendt, hypotype, A.M.N.H. No. 26274, spider viewed from the left side. $\times 25$. Only one leg is shown.

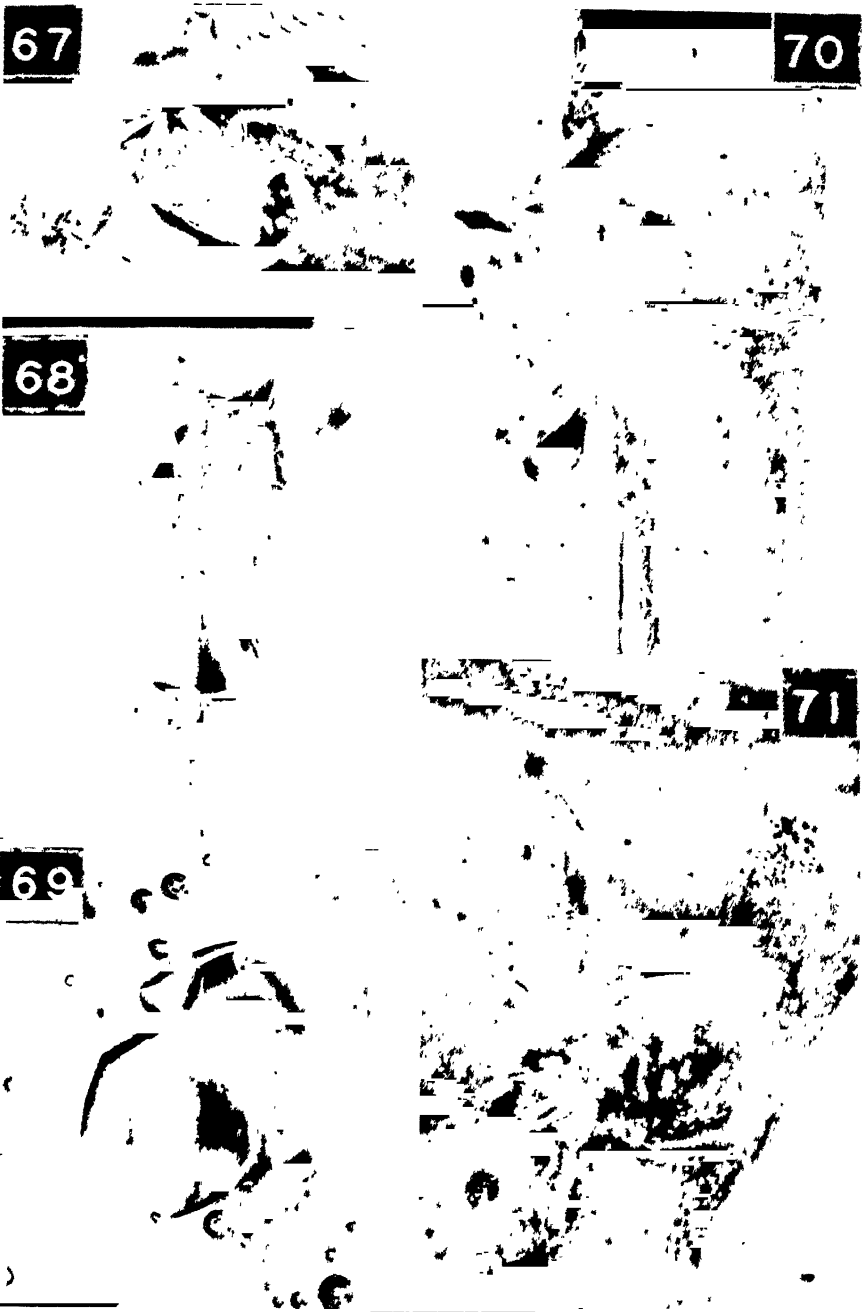
Fig. 62. Idem, eye group viewed from above. $\times 125$.

Fig. 63. Idem, ventral view of abdomen. $\times 30$. To show the position of the tracheal spiracle.

Fig. 64. Idem, retroclaw of fourth left tarsus. $\times 200$.

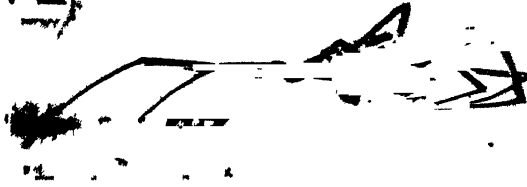
Fig. 65. Idem, carapace viewed from above. $\times 30$.

Fig. 66. Idem, spinnerets viewed from the right side. $\times 60$. The left posterior spinneret is visible above the right one, on the other side of the anal tubercle.



- Fig. 67. *Eomysena succini* Petrunkevitch, gynotype, A.M.N.H. No. 26263. $\times 9$.
 Fig. 68. *Anyphaena fuscata* Koch and Berendt, hypotype, A.M.N.H. No. 26274. $\times 10$.
 Fig. 69. *Eodipoena baltica*, new species, holotype, A.M.N.H. No. 26261. $\times 8$.
 Fig. 70. *Eustaloides setosus* Petrunkevitch, A.M.N.H. No. 26264. $\times 13$.
 Fig. 71. *Eogonatium robustum*, new species, holotype, A.M.N.H. No. 26255. $\times 13$.

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- Fig. 72. *Flegia longimana* Koch and Berendt, hypotype, A M N H No 26259 $\times 5$
 Fig. 73. *Insecutor mandibulatus* Petrunkevitch, androtype, A M N H No 26258 2 $\times 4$.
 Fig. 74. *Inceptor dubius* new species, holotype, A M N H No 26267 $\times 13$



Fig 75 *Adulatrix rufa* Petrunkevitch, androtype, A M N H No 26268 3 $\times$ 7

Fig 76 *Zachria pecuhata*, new species, holotype, A M N H No 26269 $\times$ 6

Fig 77 *Insecutor aculeatus* Petrunkevitch, A M N H No 26257 2 $\times$ 9

Fig 78 *Eocryphoea gracilipes* (Koch and Berendt), hypotype A M N H No 26256 $\times$ 9

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Fig. 79. *Clostes priscus* Menge, A.M.N.H. No. 26254. $\times 8$.

Fig. 80. *Argyroneta antiqua* Heyden, A.M.N.H. No. 26275. $\times 5$.

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NORTH AMERICAN AGELENIDAE OF THE GENUS *CORAS* SIMON

BY MARTIN H. MUMA¹

This review of North American spiders of the genus *Coras* Simon is based principally on collections deposited in the American Museum of Natural History, Museum of Comparative Zoölogy, United States National Museum, as well as the private collections of Dr. B. J. Kaston and the author. Types and paratypes of the several described species are deposited in the American Museum of Natural History. Paratypes are in the collections of the Museum of Comparative Zoölogy, the United States National Museum, and in the collections of Dr. Kaston and the author.

Acknowledgments are due Drs. Willis J. Gertsch, E. A. Chapin, B. J. Kaston, and Miss Elizabeth B. Bryant for their co-operation in providing material for the study; and to Katharine E. Muma, the author's wife, for assistance in organizing and typing this paper. The author would also like to express appreciation to Dr. Gertsch for help in obtaining literature and for helpful suggestions during the course of the study.

HISTORY OF THE GENUS

The genus *Coras* was established by E. Simon in 1898 (Hist. Nat. Araign., 1898, vol. 2, p. 258) for the species *Tegenaria medicinalis* Hentz. Until 1925 when R. V. Chamberlin (1925, Proc. Biol. Soc. Washington, vol. 38, pp. 129-134) recognized the congeneric characters of *Coelotes juvenilis* Keyserling and *Coelotes montanus* Emerton and described a fourth species, *Coras taugynus* Chamberlin, only the genotype was referred to the genus. In 1940 W. M. Barrows (1940, Ohio Jour. Sci., vol. 40, no. 3, p. 130, fig. 1) described a fifth species, *Coras cavernorum* Barrows, and in 1944 the

author (1944, Amer. Mus. Novitates, no. 1257) described three others, *Coras angularis* Muma, *Coras crescentis* Muma, and *Coras parallelus* Muma. Six additional species are described in this paper.

Chamberlin, in his 1925 paper entitled "Notes on North American spiders heretofore referred to *Coelotes*" (1925, Proc. Biol. Soc. Washington, vol. 38, pp. 119-124), separated most of the species into the genera *Coras* Simon and *Wadotes* Chamberlin and placed one or two in synonymy in the genus *Cicurina* Menge. The species *Coelotes exaptus* Banks, described in 1898 (1898, Proc. California Acad. Sci., vol. 1, no. 7, p. 231, pl. 14, fig. 27) appears to have been overlooked by him. A study of the description of *exaptus* reveals several characters such as eye arrangement, leg spination, and lack of anterior lateral tubercles on the epigynum that would exclude it from the genus *Coras*. Another species, *Coelotes plumarius* Bishop and Crosby (1926, Elisha Mitchell Sci. Soc., vol. 41, nos. 3, 4, p. 200, fig. 50), described after Chamberlin's study, is a female of *Tegenaria derhami* Scopoli.

NOTES ON SYNONYMY

Hentz's original indication of *Tegenaria medicinalis* (1821, Jour. Acad. Nat. Sci. Philadelphia, vol. 2, pt. 1, p. 53, pl. 5, fig. 1a, b) gives a fairly accurate general description and figure of the spider later placed by Simon in the genus *Coras*. Later (1847, Jour. Boston Soc. Nat. Hist., vol. 5, p. 463, pl. 24, fig. 21) Hentz further described and figured the species and, although the drawings of the eyes, male palpus, and endites and chelicerae represent *medicinalis*, the painting of the complete spider appears to be from a specimen of *Tegenaria derhami* Scopoli. In his sup-

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plement (1866, Proc. Boston Soc. Nat. Hist., vol. 11, p. 107, fig. 110), which was edited by S. H. Scudder, Hentz figured the details of the palpus of *medicinalis*. These figure and descriptions with the unfortunate exception of the 1847 painting definitely place the species *Coras medicinalis* Hentz.

Chamberlin in his 1925 paper recognized the validity of *medicinalis* and placed *Caelotes urbanus* Keyserling and *Caelotes lamellosus* Keyserling in synonymy with it. Keyserling's description and figures of *urbanus* (1887, Verhandl. Zool.-Bot. Gesellschaft. Wien, p. 467, pl. 6, fig. 31, 31a) clearly represent *medicinalis*. A careful study of material from Virginia, Pennsylvania, and Minnesota, the localities cited by Keyserling in his description of *lamellosus* (*ibid.*, p. 469, pl. 6, fig. 30, 30a, 30b), indicate, however, that this species is distinct and must be returned to its specific status.

The relegation to synonymy with *Coras juvenilis* (Keyserling) of *Caelotes fidelis* Banks proposed by Chamberlin in 1925 after his study of the immature female holotype is followed in this paper. A comparative study of Keyserling's epigynal figure of *juvenilis* (1881, Verhandl. Zool.-Bot. Gesellschaft. Wien, vol. 31, p. 288, pl. 11, fig. 13), of specimens of *Coras montanus* (Emerton), and of Barrows' figure of *Coras cavernorum* (1940, Ohio Jour. Sci., vol. 40, no. 3, p. 130, fig. 1) indicates a close relationship. However, until more material is available and more extensive study can be made, Chamberlin's placement of *juvenilis* must stand and *cavernorum* must be considered valid.

In 1944 (Amer. Mus. Novitates, no. 1257, pp. 3, 5) the author described *Coras angularis* Muma from a single male and *Coras crescentis* Muma from a female. A comparison of the types of these two species with males and females of *Coras alabama*, new species, and *Coras kisatchie*, new species, both described in this paper, shows that they represent a single species. As *angularis* has page priority over *crescentis*, it is proposed that the latter become the synonym.

GENERAL CHARACTERISTICS OF THE GENUS

The spiders of this genus like those of other genera of Agelenidae, are quite similar in size and appearance. Coloration and general structure appear to be constant throughout the genus with specific separation depending almost entirely on the structure of the genitalia. For this reason a detailed description of the structure and coloration is given here, and only specific and minor differences are discussed under the several species.

SIZE: Spiders moderate to large with considerable variation in size among individuals of the same species. Females generally larger, more robust, and with heavier, proportionately shorter legs than males.

STRUCTURE: Carapace somewhat longer than wide, widest between the second and third pair of legs, highest and arched just behind eye area, rounded over eyes to anterior margin and sloping gradually to just behind thoracic groove from which it slopes sharply to posterior margin. Clypeus nearly perpendicular and as wide or wider than the diameter of the anterior median eyes. Carapace narrowed in front, with sides nearly parallel for about one-third the length. Cephalic part clearly defined by cervical grooves. Radial furrows distinct. Thoracic groove short, deep, and longitudinal. Carapace cordate behind. Hairs of carapace longest on clypeus and over eye area. Sternum cordate and longer than wide.

Eyes in two rows occupying slightly more than one-half the width of the carapace in the cephalic area. Both eye rows lightly procurved with the posterior row slightly longer. Anterior median eyes as large as, or larger than, anterior lateral eyes, lateral eyes subequal and posterior median eyes smallest. Anterior median eyes closer to anterior laterals than to each other. Eyes of posterior row nearly equidistant. Lateral eyes separated from each other by less than a diameter. Median ocular quadrangle slightly longer than wide and somewhat narrowed in front.

Chelicerae robust, with prominent lateral condyles. Fangs strong and moderately curved. Furrows of chelicerae

armed both above and below with three distinct teeth. Endites longer than wide and widest at distal ends. Labium longer than wide and widest at base. Upper margins of the furrows of the chelicerae and inner angles of the distal ends of the endites rather densely clothed with long hairs.

Legs robust and moderately long. First and second pairs of legs directed forward, third and fourth pairs directed backward. Leg formula 4123. Coxae of all legs with a longitudinal ridge on anterior face. All legs moderately clothed with hair. Spines strong and moderately long. Tibiae of all legs armed below with three pairs of spines. Metatarsi of all legs armed below with two pairs of spines and a group of three spines at the distal ends.

Abdomen longer than wide, subovate and widest behind the middle. Spinnerets prominent, with the anterior pair shortest and posterior pair longest. Posterior spinnerets two-jointed. Abdomen moderately well clothed with long hairs.

Epigynum variously developed but always with a pair of fleshy tubercles on the anterior margin or at the anterior lateral corners.

Patella of male palpus with one or two processes on the ectal face. Tibia with one or more lobes on the ectal face. Embolus long, tubular, and looped on the mesal side of the bulb. Embolic conductor variously developed but always supporting and enclosing the tip of the embolus. Median apophysis small, and shaped somewhat like one shell of a bivalve. Terminal apophysis large, accompanying the embolic conductor and apparently acting as a secondary embolic guide. Cymbium strongly cup-shaped with the tip tapering and moderately long.

COLORATION: The coloration of the spiders of this genus is somewhat variable, not only between the different species but between individuals of the same species. The basic color of the cephalothorax, abdomen, and legs varies from a light yellow to a reddish brown, while the markings vary from a light gray to a very dark, almost black, gray. Markings occur in a general pattern typical for the genus and are more distinct on newly moulted or fresh

specimens than on old or old preserved specimens.

Cephalothorax light, darker on cephalic part and over eye area than thoracic part. Markings on cephalic part consist of two parallel, reticulate, irregular, dusky stripes that arise between the posterior median and lateral eyes and unite just in front of the thoracic groove. Anterior lateral corners of cephalic area dusky. Thoracic part darker in the middle, marked with three pairs of triangular dusky spots that form two indefinite crescentic longitudinal bars midway between the thoracic groove and the lateral margins. Lateral margins of thoracic part seamed with a dusky line. All eyes bordered with black, and the anterior medians and both laterals occur in black spots. Sternum darker on the sides than in the middle, forming an indistinct interrupted median stripe that may or may not be accompanied with light areas.

Chelicerae brown or reddish brown with light lateral condyles. Endites and labium concolorous with margins of sternum.

Legs light to dark yellow, darkening on metatarsi and tarsi and marked as follows: coxae with proximal and distal dusky bars below; trochanters unmarked; femora with proximal, median, and distal dusky bands that are interrupted above; patellae dusky at distal ends below; tibiae and metatarsi with proximal and distal dusky bands that are interrupted above; tarsi unmarked. Palpi concolorous with legs darker on tibiae and tarsi of female and patellae and tibiae of male. Abdomen light with dusky markings. Dorsum heavily spotted, with coalescence forming a dark indistinct median lanceolate bar on the basal third of the abdomen and a series of dark chevrons down the middle of the distal two-thirds of the abdomen. Venter with two parallel dusky stripes that unite in front of the spinnerets. On some specimens the mesal edges of the stripes are indistinct, causing the venter to appear reticulate with dusky markings. Spinnerets light with dusky speckling.

GROUP A

Females of this group are characterized by epigyna with a single anterior septum

which may or may not be notched along the posterior margin. The anterior lateral tubercles are robust and abruptly pointed at the apex.

Distinguishing male palpal characteristics are: the presence of a concavity on the ectal laterodorsal surface of the tibiae, the tibiae are elongated basally into a tubercle, and the form of the embolic conductor which is spatulate or subspatulate at the tip.

TYPICAL SPECIES: *Coras medicinalis* (Hentz).

Coras medicinalis (Hentz)

Figures 1-3, 21-24

Tegenaria medicinalis HENTZ, 1821, Jour. Acad. Nat. Sci. Philadelphia, vol. 2, pt. 1, p. 53, pl. 5, fig. 1a, 1b.

Tegenaria nemorensis WALCKENAE, 1841, Histoire naturelle des insectes, aptères, vol. 2, p. 10.

Caelotus urbanus KEYSERLING, 1887, Verhandl. Zool.-Bot. Gesellsch. Wien, vol. 37, p. 467, pl. 6, fig. 31.

MALES: Total length 9.00 to 12.68 mm. Carapace 3.13 to 3.80 mm. wide and 4.46 to 6.33 mm. long. Abdomen 3.82 to 4.33 mm. wide and 4.80 to 6.60 mm. long. Fourth leg 17.00 to 23.33 mm. long.

Spiders moderately large, among the largest of the genus. Structure and coloration typical. Markings are usually quite distinct.

Anterior median eyes larger than anterior lateral eyes by a ratio of 5 to 4. Clypeus somewhat wider than the diameter of the anterior median eyes.

Patella of palpus somewhat shorter than tibia. Ectal process of patella in lateral view, a short, stout, pointed spur rounded on the ventral margin, flattened on the dorsal margin and situated near the ventral margin of patella; in ventral view ectal process spatulate and projecting at an angle from patella. Tibia in ectal view strongly ridged with an acute distal lobe on the ventral margin and an acute basal lobe on the dorsal margin. Embolus long and tubular, looped across the distal end of tibia and along half of the length of the mesal edge of the cymbium. Embolic conductor subspatulate at tip with flattened portion one-third the length of the conduc-

tor. Terminal apophysis a strongly curved, flattened bar with a spatulate apex.

FEMALES: Total length 9.45 to 13.33 mm. Carapace 3.24 to 4.06 mm. wide and 4.62 to 6.71 mm. long. Abdomen 4.02 to 4.66 mm. wide and 5.03 to 6.82 mm. long. Fourth leg 14.33 to 19.68 mm. long.

Females usually somewhat more robust than males and markings are often darker and less distinct.

Anterior eye ratio and clypeal width same as in males.

Epigynum variable, somewhat wider than long. Septum with a median notch on the posterior margin that is variable in width and with sharply angled or nearly parallel sides. Extreme lateral ridges of epigynum parallel or nearly parallel with sides of median notch. Anterior lateral tubercles short, heavy, and arising in front of posterior margin of septum.

REMARKS: This species, the genotype and the type of this group, forms a distinct group with *C. parallelis* Muma and *C. furcatus*, new species. The extremely variable epigyna of the females indicate the possibility that the species is a heterogeneous mixture. However, no correlation of variable males and females could be made, even with the large series that was studied, so no separation was attempted.

TYPE LOCALITY: Hentz gave no specific type locality at the time he described the present species. Later he cited the "United States," "North Carolina in March," and "Massachusetts in May" as localities from which *medicinalis* came. Inasmuch as no types were designated and the material, with the possible exception of the palpi of one of the original specimens, has been lost, it is not possible to select a lectotype. Hentz's *medicinalis*, however, is so well known that a neotype is unnecessary.

RECORDS: *Alabama*: Auburn, one female, Nathan Banks. Sepulga River, Conecuh County, January 10, 1941, one female, A. F. Archer. *Colorado*: Denver, one male, Marx. West Cliff, one female, Marx. *Connecticut*: Hamden, June 10 and 24, 1935, two females, B. J. Kaston. Branford, April 4, 1935, one female, B. J. Kaston; September 3, 1937, two males, D. S. Riggs. Morris, July 15, 1938, three females, B. J. Kaston. Brookvale, May 8, 1935, one fe-

male, B. J. Kaston; April 20, 1938, one female, B. J. Kaston. Colchester, September 15, 1937, one female, B. J. Kaston. Norwalk, May 27, 1933, three females, W. J. Gertsch. South Meriden, June 30, 1935, one female, H. L. Johnson; March 24, 1935, one male, H. L. Johnson. New Milford, March 28, 1938, one female, A. De Caprio. East Haddam, April 21, 1935, one female, B. J. Kaston. Oxford, February 10, 1937, one male, P. H. Marvin. Avon, September 23, 1937, one male, B. J. Kaston. Macedonia, August 7, 1937, one male, B. J. Kaston. New Haven, 1932, one male, B. J. Kaston. Mt. Carmel, November 18, 1934, one female, B. J. Kaston; April 16, 1937, two females, B. J. Kaston. Cheshire, November 22, 1936, four females, one male, H. L. Johnson. *District of Columbia*: Washington, one male, Banks; two males, one female, Marx. *Florida*: Gainesville, Alachua County, October 20, 1938, one male, H. K. Wallace. *Georgia*: Gainesville, March 10, 1939, one female, B. J. Kaston. *Illinois*: Chicago, one male, Marx. *Maryland*: Parole, April 29, 1944, one female, M. H. Muma. College Park, March 12, 1945, one female, M. H. Muma; March 29, 1941, one female, M. H. Muma; September 25, 1941, one female, M. H. Muma; December 10, 1941, one female, Earl Beardsley; March 30, 1943, one male, M. H. Muma; April 27, 1941, one female, M. H. Muma; November 5, 1941, one female, E. Beardsley; March 26, 1944, one female, H. Howden; November 10, 1941, one female, M. H. Muma. Churchville, June 28, 1941, one female, M. H. Muma. Berwyn, November 11, 1942, one female, Earl Beardsley. Glen Arm, April 6, 1945, one male, M. H. Muma; September 22, 1944, two males, two females, M. H. Muma. Cranberry, September 1, 1944, one male, M. H. Muma. Bethesda, November 7, 1943, one male, J. M. Davis. Brown's Bridge, February 5, 1944, one male, one female, H. Howden. Silver Spring, April 4, 1941, one female, M. H. Muma. Cabin John, one female, J. G. Mutziger. *Michigan*: Eagle River, Lake Superior, one male, one female, Marx. *Minnesota*: Rochester, one female, Marx. *Mississippi*: Lake Horn, one female, Marx. *New Jersey*: Fort Lee, May 17, 1911, one female, G. von Krockow and Giles. Ramsey, November 19, 1934, one female, W. J. Gertsch; June 3, 1934, two females, W. J. Gertsch; September 3, 1934, one female, W. J. Gertsch; October 7, 1933, one male, W. J. Gertsch; May 6, 1934, one male, six females, W. J. Gertsch; September 9 and 18, 1933, three males, six females, W. J. Gertsch. *New York*: Forest Park, September 27, 1908, one male, one female; April 17, 1909, one male, Barnum and Giles. Sea Cliff, one male, five females, Nathan Banks. Ithaca, one female, Nathan Banks. Cold Spring Harbor, June 25, 1903, one female. Flushing, Long Island, October 7 and 12, 1934, four males, seven females, E. L. Bell. Hollis Woods, Long Island, June 22, 1943, one female, V. M. von Hagen. Tuckahoe, April 1, 1944, one female, B. Maguire, Jr., and V. M. von Hagen. Central Park West,

New York City, April 17, 1908, one female, von Krockow. Bronx Park, New York City, May 2, 1908, one female. *North Carolina*: Raleigh, October 1, 1944, one male, C. S. Brimley; October 30, 1911, one male, one female, C. S. Brimley. Chapel Hill, April 19, 1930, one male, J. C. Beakley; one female, no further data. *Oregon*: Lake Klamath, one female. *Tennessee*: Great Smoky Mountains, sides of Mt. LeConte, July 8, 1933, one female, Wilton Ivie. *Virginia*: Falls Church, two males, Nathan Banks.

Coras parallelis Muma

Figures 4, 5

Coras parallelis MUMA, 1944, Amer. Mus. Novitates, no. 1257, p. 4, fig. 6.

FEMALES: Total length 9.67 to 11.13 mm. Carapace 2.87 to 3.60 mm. wide and 4.07 to 5.13 mm. long. Abdomen 3.73 to 4.13 mm. wide and 5.80 to 6.20 mm. long. Fourth leg 14.33 to 19.46 mm. long.

Moderately large spiders. Coloration and structure typical. Dusky spots on abdomen small but forming a distinct typical pattern.

Anterior median eyes larger than the anterior lateral eyes by a ratio of 4 to 3. Clypeus nearly one and one-half times the diameter of the anterior median eyes in width.

Epigynum wider than long by a ratio of 3 to 2. Septum with a parallel-sided notch on the posterior margin that occupies one-third of the width of the septum and is variable in length. Extreme lateral ridges nearly parallel with sides of septal notch. There are two parallel grooves near the posterior margin of the epigynum that are separated by the width of the septal notch. In the holotype the notch extends back to these grooves, but in no other specimen studied does the notch extend more than two-thirds of the distance. Anterior lateral tubercles short, heavy, and arising in front of posterior margin of septum.

REMARKS: This species is quite closely related to the genotype and *C. furcatus*, new species. The male is not known.

TYPE LOCALITY: Female holotype from Princess Anne, Maryland, October 24, 1941, W. Barb, in the collection of the American Museum of Natural History.

RECORDS: *Connecticut*: Mt. Carmel, May 12, 1937, one female, B. J. Kaston. *Delaware*: Westover Hills, Wilmington, April 24, 1941,

one female, A. Bacon. *New Jersey*: Alpine, April 25, 1909, one female.

***Coras furcatus*, new species**

Figures 6, 25, 26

MALE HOLOTYPE: Total length 7.97 mm. Carapace 2.80 mm. wide and 4.00 mm. long. Abdomen 2.33 mm. wide and 4.07 mm. long. Fourth leg 17.20 mm. long.

Comparatively small spider. Coloration and structure typical except for the following differences. Dark basal lanceolate mark and first dusky chevron interrupted with the light base color. Light median stripe on venter not interrupted by a dusky area and branched in three places along its length. Venter reticulate with dusky markings rather than with two stripes.

Anterior median eyes larger than anterior lateral eyes by a ratio of 3 to 2. Clypeus width about one and one-half times the diameter of the anterior median eyes.

Palpus similar to that of *medicinalis* except as follows: Ectal patellar process strongly furcate with the apices well separated from either a lateral or ventral view. The flattened tip of the embolic conductor is broader and the base of the conductor heavier than in *medicinalis*.

FEMALE ALLOTYPE: Total length 8.60 mm. Carapace 2.73 mm. wide and 4.20 mm. long. Abdomen 3.13 mm. wide and 4.60 mm. long. Fourth leg 14.73 mm. long.

Female somewhat more robust than male and with shorter legs. Coloration and structure same as in male except that the light, median, branched stripe is interrupted with a dusky area in the posterior third of its length.

Anterior median eyes larger than anterior lateral eyes by a ratio of 3 to 2. Width of clypeus about one and one-half times the diameter of the anterior median eyes.

Epigynum wider than long by a ratio of about 2 to 1.5. Posterior margin of septum crenate, forming a wide notch with evenly rounded sides. Extreme lateral ridges form an obtuse angle with the sides of the septal notch. Anterior lateral tubercles short, stout, and arising in front of posterior margin of septum.

FEMALE PARATYPES: Total length 9.80 to 10.52 mm. Carapace 3.00 to 3.33 mm. wide and 4.20 to 4.86 mm. long. Abdomen 3.80 to 4.46 mm. wide and 5.80 to 5.86 mm. long. Fourth leg 12.66 to 19.33 mm. long.

REMARKS: This species is closely related to *C. medicinalis* (Hentz) and *C. parallelis* Muma. From the material studied it appears to be confined to the Gulf coast states.

TYPE LOCALITY: Male holotype and female allotype from Pensacola, Florida, January 31, 1925, W. M. Barrows.

RECORDS: *Florida*: Alachua County, January 12, 1938, female paratype, B. J. Kaston. Dudley's Caves, Alachua County, March 18, 1938, female paratype, W. J. Geitich. Pensacola, Ferry Pass, January 31, 1925, female paratype, W. M. Barrows.

***Coras lamellosus* (Keyserling)**

Figures 7, 27-30

Caelotes lamellosus KEYSERLING, 1887, Verhandl. Zool.-Bot. Gesellsch. Wien, p. 469, pl. 6, fig. 30, 30a, 30b.

MALES: Total length 8.49 to 12.33 mm. Carapace 2.86 to 3.53 mm. wide and 5.06 to 6.00 mm. long. Abdomen 2.46 to 4.60 mm. wide and 3.53 to 6.53 mm. long. Fourth leg 17.53 to 21.40 mm. long.

Spiders commonly moderate in size. Coloration and structure typical. Colors usually strikingly contrasted, making the markings distinct.

Anterior median eyes larger than anterior lateral eyes by the ratio of 3 to 2.5. Width of clypeus about one and one-half times the diameter of an anterior median eye.

Patella of palpus somewhat shorter than tibia. Ectal patellar process of palpus a stout, elongate, distal spur situated near the ventral margin of the segment. In lateral view the sides of the process are nearly parallel and the tip subcuneate with an acute apex over the dorsal margin. In ventral view the spur curves outward and is bilobed at the tip. The tibia of the palpus is strongly ridged in ectal view and is provided with an acute distal lobe on the ventral margin and a large, rounded, basal lobe on the dorsal margin. Embolus tubular, considerably shorter than in *C.*

medicinalis (Hentz) and looped across the face of the bulb. Embolic conductor with a bulb-like base and margins that taper gradually to the small subspatulate tip that is provided with a projecting distal spine. Terminal apophysis plate-like with a narrow twisted tip that accompanies the embolic conductor. Cymbium strongly cup-shaped and distinctly ridged on the ectal margin of the ventral face.

FEMALES: Total length 8.12 to 13.19 mm. Carapace 2.33 to 3.66 mm. wide and 3.66 to 5.66 mm. long. Abdomen 2.66 to 5.93 mm. wide and 4.66 to 7.73 mm. long. Fourth leg 11.60 to 19.26 mm. long.

Females generally slightly more robust than males. Coloration and structure similar to males.

Anterior eye ratio and clypeal width the same as in the males.

Epigynum wider than long by a ratio of 1.4 to 1. Posterior margins of septum nearly straight and angled sharply toward posterior end of epigynum, forming a notch about one-third the width of the septum with strongly sloping sides. Extreme lateral ridges of epigynum form an angle of less than 90° with the posterior margin of the septum. Anterior lateral tubercles stout and long, extending backward beyond the septum.

REMARKS: This species forms a closely related group with the two following species, *C. perplexus*, new species, and *C. aerialis*, new species. Although the species is widely distributed, it seems to be more common in the central part of the country.

RECORDS: *Arkansas:* Berryville, fall, 1938, two males and three females, C. Wilton. *California:* San Francisco, one female. *District of Columbia:* Washington, two females, Marx; one male, Nathan Banks. *Illinois:* Cook County, one male and one female, R. V. Chamberlin. Kickapoo State Park, October, 1942, two males. New Lenox, April 16, 1932, one male, D. C. Lowrie; October 26, 1936, one female, M. Sharp. Chicago, one female. Willow Springs, Cook County, August 27, 1942, one male and one female, Borys Malkin. *Indiana:* Three males and four females, no further data. *Kansas:* Manhattan, one male, Nathan Banks. *Louisiana:* Kisatchie National Forest, Grant Parish, June, 1941, one male and six females, Jones and Archer. *Minnesota:* Minneapolis, May 18 to June 4, 1931, two males and four females, W. J. Gertsch. Lake Pepin, Waconta

Beach, May 15, 1932, five females, W. J. Gertsch; April 25, 1931, one female, W. J. Gertsch. *Mississippi:* Lake Horn, one female. *Nebraska:* Seward, August 8 to October 19, 1945, eight males and seven females, M. H. Muma. Plattsmouth, March 26, 1923, one female, L. G. Worley. Gilead, October 30, 1945, two males and two females, M. H. Muma. *Scotia,* October 17, 1945, one female, M. H. Muma. *Oregon:* Lake Klamath, one male, Marx. *Pennsylvania:* York, one male, Marx. Altoona, one male. Washington, June 7, 1929, one male, W. W. Long.

Coras aerialis, new species

Figures 8, 31, 32

Coelotes medicinalis EMERTON, 1889, Trans. Connecticut Acad. Sci., vol. 8, p. 191, fig. 1a, 1b, 1c.

Coras lamellosus MUMA, 1944, Amer. Mus. Novitates, no. 1257, p. 4, fig. 4.

MALE HOLOTYPE: Total length 11.69 mm. Carapace 4.20 mm. wide and 6.06 mm. long. Abdomen 3.53 mm. wide and 5.73 mm. long. Fourth leg 22.00 mm. long.

Comparatively large spider. Coloration and structure typical. Entire coloration somewhat darker than usual.

Anterior median eyes larger than anterior lateral eyes by the ratio of 3 to 2. Width of clypeus about one and one-half times the diameter of the anterior median eyes.

Structure of palpus similar to that of *C. lamellosus* (Keyserling). It may be distinguished from *lamellosus* by differences in the ectal patellar process and embolic conductor. The patellar process in lateral view is bent slightly near the tip, and the tip is irregularly blunt. In ventral view the tip of the process is undulate. The embolic conductor is stout with a broad flattened tip and a large distal spine.

FEMALE ALLOTYPE: Total length 11.72 mm. Carapace 3.80 mm. wide and 5.46 mm. long. Abdomen 4.60 mm. wide and 6.46 mm. long. Fourth leg 19.53 mm. long.

Female nearly same size as male, legs slightly shorter and stouter. Coloration and structure same as male.

Anterior eye ratio and clypeal width same as for male.

Epigynum wider than long by a ratio of 1.6 to 1. Posterior margins of septum angled as in *C. lamellosus* (Keyserling) but evenly rounded rather than straight. Septal notch considerably wider than in

lamellosus. Extreme lateral ridges form a noticeably acute angle with the sides of the septal notch. Anterior lateral tubercles stout, short, and extending nearly parallel to the posterior margin of the septum.

FEMALES: Total length 9.49 to 13.39 mm. Carapace 2.80 to 4.33 mm. wide and 4.33 to 6.66 mm. long. Abdomen 3.60 to 5.40 mm. wide and 5.26 to 6.93 mm. long. Fourth leg 13.53 to 20.73 mm. long.

REMARKS: This species is closely related to *C. lamellosus* (Keyserling) and *C. perplexus*, new species. It appears to be confined to the northeastern part of the United States.

TYPE LOCALITY: Male holotype and female allotype from Deep Creek Lake, Maryland, May 30, 1941, M. H. Muma.

RECORDS: *Maryland:* Deep Creek Lake, September 13, 1943, two male and three female paratypes, M. H. Muma; May 30, 1941, two female paratypes, M. H. Muma; May 5, 1944, one female paratype, M. H. Muma; April 30, 1941, two females, M. H. Muma; August 23, 1942, one female, M. H. Muma. *Massachusetts:* Swampscott, May 8, 1873, one male and one female, paratypes, Emerton. Hammonds Pond Woods, November 8, 1904, one female, Miss E. B. Bryant. Franklin Park, March 2, 1901, one female, Miss E. B. Bryant. *New Hampshire:* Randolph, September 10–14, 1939, one female, E. L. Bell. *New York:* Valcour Island, September, 1938, one male and one female, paratypes, H. Seton. Poughkeepsie, one female Banks.

Coras perplexus, new species

Figures 9, 33, 34

MALE HOLOTYPE: Total length 6.89 mm. Carapace 2.53 mm. wide and 3.46 mm. long. Abdomen 2.20 mm. wide and 3.53 mm. long. Fourth leg 15.46 mm. long.

Comparatively small spider. Coloration and structure typical. Markings on sternum quite distinct; two light areas accompany the median stripe on each side. Venter with large, dusky, reticulate markings.

Anterior median eyes larger than anterior lateral eyes by a ratio of 2.5 to 2. Clypeus somewhat wider than the diameter of the anterior median eyes.

Structure of palpus similar to that of *C. lamellosus* (Keyserling). It may be separated from that species by the ectal process

of the patella which is considerably shorter, stouter, and furcate at the tip in lateral view and spatulate in ventral view. The distal spine of the embolic conductor is well removed from the tip of the conductor.

MALES: Total length 6.82 to 8.69 mm. Carapace 2.53 to 3.06 mm. wide and 3.42 to 4.53 mm. long. Abdomen 2.20 to 2.66 mm. wide and 3.50 to 4.26 mm. long. Fourth leg 15.26 to 18.20 mm. long.

In some specimens the ventral apex of the patellar process is bent ectally so that the process appears to have only one apex in lateral view.

FEMALE ALLOTYPE: Total length 8.76 mm. Carapace 2.53 mm. wide and 3.66 mm. long. Abdomen 3.13 mm. wide and 5.20 mm. long. Fourth leg 13.60 mm.

Somewhat more robust than male. Coloration and structure similar to the male except as follows: markings lighter, only one pair of light areas on sternum, and venter with finer reticulate markings.

Anterior eye ratio and clypeal width same as in male.

Epigynum similar to *C. lamellosus* (Keyserling) and *C. aeralis*, new species. Epigynum wider than long by a ratio of 2 to 1. Posterior margins of septum curved, not sharply angled posteriorly, and forming a wide flat notch. Extreme lateral ridges form a right or obtuse angle with the posterior margins of the septum. Anterior lateral tubercles stout, short, and not extending to posterior margin of septum.

FEMALES: Total length 6.63 to 9.23 mm. Carapace 2.20 to 2.80 mm. wide and 3.33 to 4.00 mm. long. Abdomen 2.40 to 3.33 mm. wide and 3.40 to 5.33 mm. long. Fourth leg 11.13 to 14.86 mm. long.

REMARKS: This species is closely related to *C. lamellosus* (Keyserling). It seems to be confined to the Gulf coast states.

TYPE LOCALITY: Male holotype and female allotype from Hattiesburg, Mississippi, January 2 to 6, 1942, E. L. Bell.

RECORDS: *Alabama:* Mobile County, one male and three females, paratypes, H. P. Loding. Mobile, one male, and one females paratypes, R. V. Chamberlin. *Mississippi:* Centreville, Wilkinson County, January to July, 1944, one male, one female, A. F. Archer. Hattiesburg, January 2 to 23, 1942, eight male and 11 female paratypes, E. L. Bell.

Coras angularis Muma

Figures 10, 35-38

Coras angularis Muma, 1944, Amer. Mus. Novitates, no. 1257, p. 3, figs 2, 3.

Coras crescentis Muma, 1944, Amer. Mus. Novitates, no. 1257, p. 4, fig. 5.

MALE HOLOTYPE: Total length 8.55 mm. Carapace 2.73 mm. wide and 4.05 mm. long. Abdomen 2.42 mm. wide and 4.50 mm. long. Fourth leg 13.86 mm. long.

Moderate-sized spider. Coloration and structure typical. Sternal stripe narrow and not accompanied by distinct light areas.

Anterior median eyes larger than anterior lateral eyes by a ratio of 3 to 1.75. Clypeus somewhat wider than diameter of the anterior median eyes.

Patella of palpus shorter than tibia. Patella has two widely separated ectal processes. Both processes are short and stout, that nearest the ventral edge of the patella being acuminate while the other is unevenly rounded. Only the acuminate process is visible in ventral view. Basal and distal lobes of tibia small and acuminate in lateral view. Embolus long, tubular, and looped across the distal end of the tibia. Embolic conductor bulb-like at base and curving evenly to the spoon-shaped tip. There is no spine or spur at the tip of the conductor. Terminal apophysis with an elongate blade-like tip that is twisted and bent toward the cymbium near the tip.

FEMALE ALLOTYPE: Total length 9.75 mm. Carapace 3.00 mm. wide and 4.35 mm. long. Abdomen 3.62 mm. wide and 5.40 mm. long. Fourth leg 16.11 mm. long.

Somewhat more robust than male. Coloration and structure typical. Base color darker than usual, a yellowish brown.

Anterior eye ratio and clypeal width same as in male.

Epigynum wider than long by a ratio of 2 to 1.5. Median septum with no notch on posterior margin and with the margin undulate. Anterior lateral tubercles stout, elongate, and paralleling the posterior margin of the septum. The tubercles arise behind the septum.

REMARKS: This species forms a closely related group with *C. alabama*, new species,

and *C. kisatchie*, new species. It has been found only in Maryland.

TYPE LOCALITY: Male holotype, Swallow Falls State Park, Maryland, August 24, 1942, M. H. Muma, in the collection of the American Museum of Natural History.

RECORD: *Maryland:* Dans Rock, November 23, 1941, female allotype, M. H. Muma.

Coras alabama, new species

Figures 11, 39, 40

MALE HOLOTYPE: Total length, not measurable. Carapace 2.00 mm. wide and 3.20 mm. long. Abdomen crushed and not measurable. Fourth legs missing.

Specimen badly mangled but appears to be comparatively small. Coloration and structure typical of genus.

Anterior median eyes larger than anterior lateral eyes by a ratio of 3 to 2. Clypeus only a little wider than the diameter of the anterior median eyes.

Palpus similar to *C. angularis* Muma except as follows: Both ectal patellar processes acuminate, that nearest the ventral margin being considerably larger and bent at an angle for the distal half of its length. Processes widely separated. Embolic conductor sinuate rather than evenly curved from base to tip.

FEMALE ALLOTYPE: Total length 10.73 mm. Carapace 3.33 mm. wide and 5.00 mm. long. Abdomen 3.93 mm. wide and 5.93 mm. long. Fourth leg 16.73 mm. long.

Moderately large spider. Coloration and structure typical for genus.

Anterior eye ratio same as in male. Clypeus nearly twice diameter of anterior median eyes.

Epigynum wider than long by a ratio of 2 to 1.5. Posterior margin of septum curved and sharply angled posteriorly but not forming a notch. Anterior lateral tubercles robust, elongate, and gently tapered at tips; they arise behind and lie parallel to the posterior margin of the septum.

FEMALE PARATYPES: Total length 9.03 to 10.26 mm. Carapace 2.73 to 3.26 mm. wide and 4.80 to 4.86 mm. long. Abdomen 3.00 to 3.86 mm. wide and 4.53 to 5.60 mm. long. Fourth leg 15.00 to 16.53 mm. long.

REMARKS: This species is closely related to *C. angularis* Muma and *C. kisatchie*, new species. Material from two localities in Alabama and one in Louisiana exhibits characters that separate it from both of these species. However, when longer series are obtained they may show integration with *kisatchie*.

TYPE LOCALITY: Male holotype and female allotype, Monte Sano, Madison County, Alabama, 1939 and 1940, A. F. Archer.

RECORDS: *Alabama*: Saltpetre Cave, Jackson County, June, 1940, one female paratype, A. F. Archer. Monte Sano, Madison County, December, 1940, five female paratypes, A. F. Archer. *Louisiana*: DeRidder, 1944, two females, Mrs. E. L. Bell, Jr.

Coras kisatchie, new species

Figures 12, 41, 42

MALE HOLOTYPE: Total length, 9.39 mm. Carapace 3.46 mm. wide and 4.66 mm. long. Abdomen 4.93 mm. wide and 3.20 mm. long. Fourth leg 16.60 mm. long.

Spider moderately large. Coloration and structure typical. Abdomen blistered but color pattern seems to be typical.

Anterior median eyes larger than anterior lateral eyes by a ratio of 3 to 2. Width of clypeus about one and one-half times the diameter of the anterior median eyes.

Palpus similar to that of *C. angularis* Muma and *C. alabama*, new species. Ectal processes of patella similar to those of *alabama* except that the one nearest the ventral margin of the segment is not bent, the dorsal one is comparatively large, and the two are not widely separated. Embolic conductor with a heavy bulb-like base and a sharp constriction just behind the spoon-like tip. Terminal apophysis considerably larger than in the related species and not twisted.

FEMALE ALLOTYPE: Total length 11.59 mm. Carapace 3.80 mm. wide and 5.66 mm. long. Abdomen 5.13 mm. wide and 8.13 mm. long. Fourth leg 18.13 mm. long.

Large spider. Coloration and structure typical. Abdomen blistered so that color pattern is obliterated.

Anterior eye ratio and clypeal width same as in male.

Epigynum wider than long by the ratio of 2 to 1.6. Posterior margin of septum scalloped and sharply angled posteriorly. Anterior lateral tubercles short, broad, and abruptly pointed at tips. Tubercles arise behind and lie parallel to the posterior margin of the septum.

FEMALE PARATYPE: Total length 8.59 mm. Carapace 2.40 mm. wide and 3.73 mm. long. Abdomen 3.13 mm. wide and 5.06 mm. long. Fourth leg 13.00 mm. long.

REMARKS: This species is held separate from *C. alabama*, new species, on the basis of the characters given. It has been collected from only one locality, however, and may prove to be synonymous with that species.

TYPE LOCALITY: Male holotype and female allotype, Kisatchie National Forest, Grant Parish, Louisiana, June, 1941, Jones and Archer.

RECORD: *Louisiana*: Kisatchie National Forest, Grant Parish, June, 1941, one female, paratype, Jones and Archer.

GROUP B

Females of this group are characterized by epigyna with two median septa which may arise from either the anterior or posterior margin or lie between the margins. The anterior lateral tubercles are slender and taper gradually toward the apex.

Male palpal characteristics are: the presence of a tubercle near the distal end of the tibiae on the ectal laterodorsal surface and the form of the embolic conductor which is variously developed but never spatulate or subspatulate.

TYPICAL SPECIES: *Coras montanus* (Emerton).

Coras montanus (Emerton)

Figures 16, 17, 43-46

Coelotes montanus EMERTON, 1889, Trans. Connecticut Acad. Sci., vol. 8, p. 192, pl. 7, fig. 3, 3a.

MALES: Total length 8.23 to 9.73 mm. Carapace 2.86 to 3.40 mm. wide and 4.13 to 4.80 mm. long. Abdomen 2.60 to 3.13 mm. wide and 4.20 to 5.13 mm. long. Fourth leg 18.33 to 20.66 mm. long.

Moderate-sized spiders. Coloration and structure typical. Dusky markings usually quite dark with base color in sharp contrast.

Anterior median eyes larger than anterior lateral eyes by a ratio of 3 to 2. Width of clypeus about one and one-half times the diameter of the anterior median eyes.

Patella of palpus slightly smaller than tibia. Ectal patellar process in lateral view with two curved opposing apices, of which the dorsal is larger. In ventral view the patellar process appears as a single acute spur. Tibia, in ectal view, with a distal lobe on the ventral margin and a small truncate lobe on the lateral face. Embolus tubular and looped along the mesal edge of the cymbium to the base of the embolic conductor. Embolic conductor a tapering, abruptly pointed structure that is bent at a right angle near the middle of its length. Terminal apophysis with an elongate spiral process that accompanies the embolic conductor across the face of the palpus and curves dorsally toward the cymbium near the ectal edge.

FEMALES: Total length 9.70 to 13.13 mm. Carapace 3.33 to 4.26 mm. wide and 5.00 to 6.00 mm. long. Abdomen 3.60 to 3.86 mm. wide and 4.90 to 7.33 mm. long. Fourth leg 16.20 to 17.93 mm. long.

Moderate to large-sized spiders. Coloration and structure same as in male.

Anterior eye ratio and clypeal width same as in male.

Epigynum wider than long by a ratio of 2 to 1. Paired septa arise on posterior margin and extend angularly outward toward the anterior lateral corners for one-third to one-half the length of the epigynum. The septa are widely separated. Anterior lateral tubercles gradually tapered from base to tip and acutely pointed. Epigynum somewhat variable with septa being indistinct in many cases.

REMARKS: This species, which is typical of this group, appears to be quite variable, especially in the details of the epigynum. Variation in epigyna could not be correlated with differences in the palpi so no separation was attempted. *C. cavernorum* Barrows may, when the type is studied,

prove to be synonymous with this species. *C. montanus* (Emerton) is a northern species and has not been taken south of New York State.

RECORDS: *Connecticut:* Mohawk Mountain, Cornwall, May 12, 1935, one male, B. J. Kaston. South Hill, October 2, 1900, one male, Petrunkévitch. *Maine:* Mt. Desert Island, one male and one female, W. Procter. *Minnesota:* Minneapolis, May 17, 1932, one female, W. J. Gertsch. *New Hampshire:* Randolph, September 10-17, three males and six females, E. L. Bell. *New York:* Liberty, September 9, 1936, one female, M. Usdin. Adirondacks, one female, Marx. *Newfoundland:* Bay Island, August, 1912, one female, Leroy. Stephenville Crossing, Bay St. George, July, 1912, two females, Engelhart. St. John's, June 24, 1919, one male and one female, Arthur English. *Nova Scotia:* Cheticamp, Cape Breton Island, one male. *Ontario:* Haliburton, June 1, 1940, one female, N. P. Smith; August 9, 1941, one female, S. Harrod. Skeleton Lake, one female, S. Harrod. *Quebec:* North entrance to Gaspé National Park, August 8, 1940, one female, A. M. and L. I. Davis. Bonaventure Island, August 1, 1941, one female, V. Crich. Seven Islands, August 19, 1924, one female, Waugh.

Coras cavernorum Barrows

Coras cavernorum BARROWS, 1940, Ohio Jour. Sci., vol. 40, no. 3, p. 130, fig. 1.

This species is known only from the holotype which was not available for this study. The original description is transcribed below:

"FEMALE: Total length 13 mm. Cephalothorax 6 mm. Abdomen 7 mm. Cephalothorax widest part between second and third leg, 4 mm. Cephalothorax at eye region, 2.6 mm. Width of posterior lateral eyes, 1.6 mm. Length of first leg, 20 mm.

"Cephalothorax with the usual markings. A dark line from posterior lateral eyes to an elongated hexagonal light area which has its posterior point on the outside of a dark hexagonal area which ends lateral to the dorsal groove. A faint line from posterior middle eyes to the elongated light hexagonal area. The anterior angle of this area bisected by a dark line which is an extension of the line from the posterior lateral eyes.

"Anterior part of head a rich yellowish brown. This color becomes lighter toward

the posterior edge of the cephalothorax where it is lemon color.

"The legs are the same color as the head except the distal end of femur and the patella which are lemon. Faint bars show on the upper side of femora and tibiae. The femora underneath show three well marked dark bars; the first or basal is narrow; the second or middle bar and the subapical are broad.

"Abdomen a dark greenish gray. The indefinite pattern is made up by the underlying white which shows through. A basal dark stripe extends half the length of the abdomen. It is broken in the middle by a white spot between two muscle impressions. On the posterior part are five chevrons. The two anterior are broad and irregular flocculent white spots. The three posterior are inverted V marks, each made up of a single row of small white dots. Just above each posterior spinneret a long white horizontal dash mark.

"Venter of abdomen with a long dark shield-shaped center broken by two small white spots just below the epigynum. The dark center is surrounded by large irregularly placed white spots. Sides of venter dark with small white dots.

"Epigynum wide, but narrow from front to back.

"Sternum dark with a central light line which nearly meets a posterior light diamond mark.

"One female from a small cave six miles west of Waynesville, N. C., at 3500 ft. September 30, 1936. A. Stupka Coll."

REMARKS: Barrows' figure of the epigynum closely agrees with that of *C. montanus* (Emerton). Until a study of the type can be made, however, the name *cavernorum* must be validated.

Coras tennesseensis, new species

Figures 20, 47, 48

MALE HOLOTYPE: Total length 9.13 mm. Carapace 3.20 mm. wide and 4.53 mm. long. Abdomen 3.13 mm. wide and 4.80 mm. long. Fourth leg 20.40 mm. long.

Moderate-sized spider. Coloration and structure typical for genus except as follows: markings unusually distinct for males, triangular spots on cephalothorax

blended to form distinct stripes, light median stripe on sternum continuous, leg bands dark.

Anterior median eyes larger than anterior lateral eyes by a ratio of 3 to 2. Width of clypeus nearly two times the diameter of the anterior median eyes.

Palpus similar to that of *C. montanus* (Emerton) except for the following: Ectal process of patella with a single ventrally hooked apex in lateral view; in ventral view the ectal process appears as a broad, gradually tapering spur with a blunt tip. Tibial lobes and embolus the same as in *montanus*. Embolic conductor a wide angular structure with a short, needle-like apex. Terminal apophysis plate-like with two short spatulate arms that are partially hidden by the embolic conductor in ventral view.

MALE PARATYPE: Total length 9.53 mm. Carapace 3.26 mm. wide and 4.73 mm. long. Abdomen 3.66 mm. wide and 5.00 mm. long. Fourth leg 21.13 mm. long.

FEMALE ALLOTYPE: Total length 9.72 mm. Carapace 3.60 mm. wide and 4.86 mm. long. Abdomen 3.40 mm. wide and 5.06 mm. long. Fourth leg 17.86 mm. long.

Spider slightly larger and more robust than male. Coloration and structure typical and similar to male.

Anterior eye ratio same as male. Clypeus width one and one-half times the diameter of the anterior median eyes.

Epigynum wider than long by a ratio of 2 to 1.2. The paired septa are widely separate and, although they lie in the middle of the epigynum, are slightly nearer the anterior margin. Each septum is bent on a right angle with the apex extending toward the lateral margin. Anterior lateral tubercles short with a bulb-like base and a short, needle-like tip. Posterior lateral corners of epigynum elevated and projected backward into angular lobes.

FEMALE PARATYPE: Total length 8.66 mm. Carapace 3.06 mm. wide and 4.06 mm. long. Abdomen 3.00 mm. wide and 4.86 mm. long. Fourth leg 16.20 mm. long.

REMARKS: This species, which is related to *C. taugymus* Chamberlin, has been found in only two southern states, North Carolina and Tennessee.

TYPE LOCALITY: Male holotype and female allotype from Gatlinburg, Tennessee, September 23, 1934, W. M. Barrows.

RECORDS: *North Carolina:* One male paratype, no further data. *Tennessee:* Montvale Spring, March, 1939, one female paratype, W. M. Barrows.

Coras taugynus Chamberlin

Figures 18, 19, 49, 50

Coras taugynus CHAMBERLIN, 1925, Proc. Biol. Soc. Washington, vol. 38, p. 124.

MALE ALLOTYPE: Total length 11.46 mm. Carapace 3.80 mm. wide and 6.00 mm. long. Abdomen 3.33 mm. wide and 5.66 mm. long. Fourth leg 23.73 mm. long.

Large spider. Coloration and structure typical. Dusky markings distinct. Median sternal stripe continuous.

Anterior median eyes larger than anterior laterals by a ratio of 3 to 2. Clypeus width one and one-half times the diameter of the anterior median eyes.

Palpus quite similar to *C. tennesseensis*, new species. Ectal process of patella large, two-thirds as long as the patella. In lateral view, process is broad at base and abruptly narrowed near apex which is slightly hooked downward. In ventral view process tapers gradually to apex. Embolus tubular and looped along mesal edge of the cymbium to the base of the embolic conductor. Embolic conductor in ventral view broad at base, bent at right angles, acutely pointed at apex, and with a spur on the distal margin near the apex. Terminal apophysis plate-like with two short spatulate arms that are partially hidden by the embolic conductor in ventral view.

FEMALE PARATYPE: Total length 11.06 mm. Carapace 3.40 mm. wide and 5.06 mm. long. Abdomen 4.26 mm. wide and 6.20 mm. long. Fourth leg 19.00 mm. long.

Moderate-sized spider. Coloration and structure typical. Old alcoholic specimen with markings obscure.

Anterior eye ratio and clypeal width same as in male.

Epigynum wider than long by a ratio of 2 to 1.2. Septa U-shaped and situated close together in the middle of the epi-

gynum nearer the posterior margin. Each septum is partly or completely covered by a rounded fleshy flap or lobe which is provided at the anterior lateral corner with what seems to be a flexible hinge. Anterior lateral tubercles bulb-like at base with an elongate tip that extends over the septal lobe. Posterior lateral corners of epigynum elevated and projected posteriorly in rounded lobes. Measurements of several females: Total length 8.96 to 12.73 mm. Carapace 2.73 to 3.20 mm. wide and 4.40 to 4.93 mm. long. Abdomen 3.00 to 5.80 mm. wide and 4.46 to 8.00 mm. long. Fourth leg 17.00 to 19.73 mm. long.

REMARKS: This species and *C. tennesseensis* are closely related.

RECORDS: *Alabama:* Cave Spring Cave, Morgan County, August and December, 1939, two females, Jones and Archer. McFarlan Cave, near Garth, Jackson County, February 29, 1940, two females, Jones and Archer. Horseshoe Cave, near Algood, Blount County, March 8, 1940, one female, W. B. Jones. De Sota Park, De Kalb County, December, 1937, one male and two females, Jones. Monte Sano, Madison County, 1940, one male allotype and one female, A. F. Archer. *North Carolina:* Black Mountains, one female paratype, Banks. *Tennessee:* Montvale Springs, March 18, 1929, one female.

Coras juvenilis (Keyserling)

Figures 13-15, 51, 52

Coelotes juvenilis KEYSERLING, 1881, Verhandl. Zool.-Bot. Gesellsch. Wien, vol. 31, p. 288, pl. 11, fig. 13.

Coelotes longitarsus EMERTON, 1889, Trans. Connecticut Acad. Sci., vol. 8, p. 192. (One female type, not illustrated.)

Coelotes fidelis BANKS, 1892, Proc. Acad. Nat. Sci. Philadelphia, p. 24, pl. 41, fig. 72, pl. 5, fig. 72.

Coelotes lineatus BANKS, 1892, Proc. Acad. Nat. Sci. Philadelphia, p. 25 (immature).

Coelotes fidelis BANKS, 1916, Proc. Acad. Nat. Sci. Philadelphia, p. 70, pl. 10, fig. 8.

MALES: Total length 6.09 to 9.23 mm. Carapace 2.20 to 3.13 mm. wide and 3.26 to 4.73 mm. long. Abdomen 1.86 to 2.80 mm. wide and 2.93 to 4.60 mm. long. Fourth leg 14.80 to 19.66 mm. long.

This species contains the smallest spiders of the genus. Coloration and structure typical. Markings usually are light though distinct. Dusky areas often small and well separated.

Anterior median eyes larger than anterior lateral eyes by a ratio of 2 to 1. Clypeus somewhat wider than the diameter of the anterior median eyes.

Ectal process of the patella of the palpus furcate in both lateral and ventral views. In lateral view the apices are rounded, the dorsal larger than the ventral and notched on the dorsal margin, and are separated by a narrow slot. In ventral view both apices are acuminate and are separated by a notch. Tibia typical for the group. Embolus tubular and looped along the mesal edge of the cymbium to the base of the embolic conductor. Embolic conductor short and stout, bulb-like at base and lobate at tip. Terminal apophysis, an elliptical plate-like structure.

FEMALES: Total length 6.66 to 10.13 mm. Carapace 2.33 to 2.93 mm. wide and 3.53 to 4.33 mm. long. Abdomen 2.13 to 4.26 mm. wide and 3.13 to 6.00 mm. long. Fourth leg 13.53 to 16.66 mm. long.

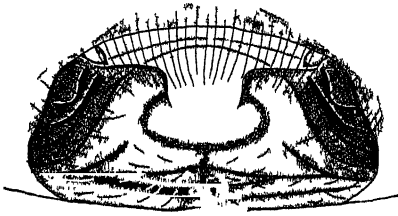
Slightly larger and more robust than males. Coloration and structure typical for genus. Colors usually darker than in male.

Anterior eye ratio and clypeal width the same as in the male.

Epigynum wider than long by a ratio of 2 to 1.4. Septa adjacent, linear and elongate longitudinally extending from the posterior margin almost to the anterior margin. They are variable but usually slightly undulate and separated more widely at the anterior ends. Anterior lateral tubercles slender and tapered gradually from base to tip.

REMARKS: This species, although related to the other species of this group, does not have close affinities with any other species. The synonymy cited is that of Dr. R. V. Chamberlin, as the author has not studied the types of any of the synonymized species.

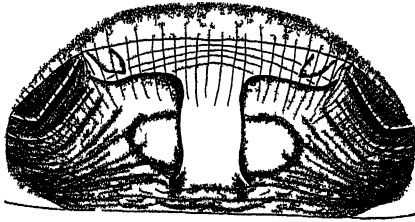
RECORDS: *Connecticut:* Barkhamstead, October 21, 1936, one female, B. J. Kaston. New Haven, 1932, one female, B. J. Kaston. Union, April 18, 1937, one female, B. J. Kaston. Bethany, September 5, 1936, one male, B. J. Kaston. Putnam, October 19, 1935, one female, B. J. Kaston. Roxbury, September 26, 1937, one female, B. J. Kaston. Griswold, April, 1936, two males and four females, A. De Caprio. Mt. Carmel, November 18, 1934, one female, B. J. Kaston. *Indiana:* Turkey Run, October 14, 1933, one male, C. F. Johnson. *Maryland:* Rocky Gap, November 21, 1941, three females, M. H. and K. E. Muma. Swallow Falls, May 31, 1941, two females, M. H. Muma. Salt Rock Creek, August 28, 1942, one male, M. H. Muma. Dans Rock, September 15, 1943, three males and two females, H. E. Muma. Deep Creek Lake, July 4, 1941, one female, M. H. and K. E. Muma. *Michigan:* Elk Lake, September, 1928, two females, S. Wright. *New York:* one female, Horace W. Britcher, no further data. September 5, 1900, one male, Horace W. Britcher, no further data. Glen House, one female, Horace W. Britcher. Sloatsburg, October 12, 1934, one male, W. J. Gertsch. Haverstraw, June 24, 1939, two females, W. J. Gertsch. Lake Sebago, October 8, 1933, one male and one female, W. J. Gertsch. Ithaca, April 26, 1937, one female, Gerberg, Greenspan. *Pennsylvania:* Johnstown, September 6, 1935, two females. *Vermont:* Passumpsic, one female, Granger. *Virginia:* Giles County, August 9, 1935, two females, H. H. Hobbs. *West Virginia:* Forks of the Cacapon near Ace Mountain, May 8, 1939, one female, E. L. Bell.



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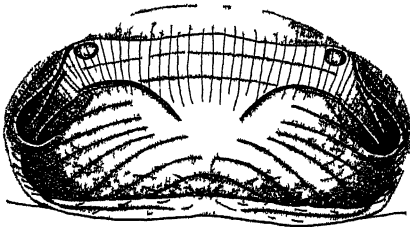
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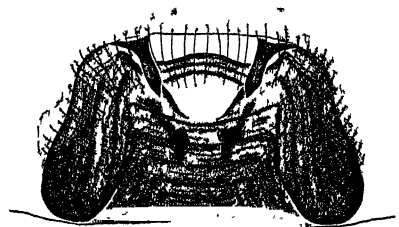
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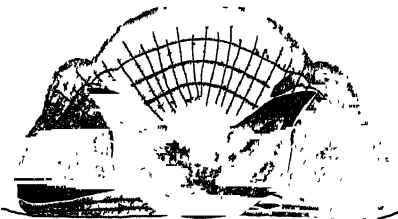
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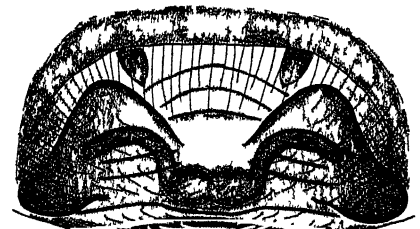
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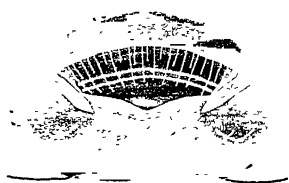


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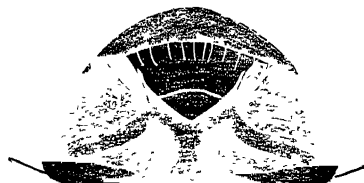


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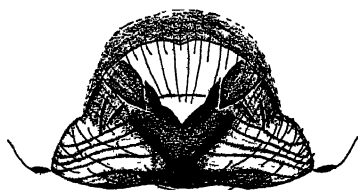
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 Fig 2 *Coras medicinalis* (Hentz) variation of septal notch.
 Fig 3 *Coras medicinalis* (Hentz) variation of septal notch.
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 Fig 8 *Coras aeneus* new species, epigynum, ventral view
 Fig 9 *Coras perplectus* new species, epigynum ventral view



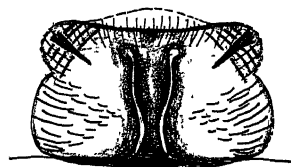
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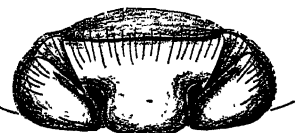
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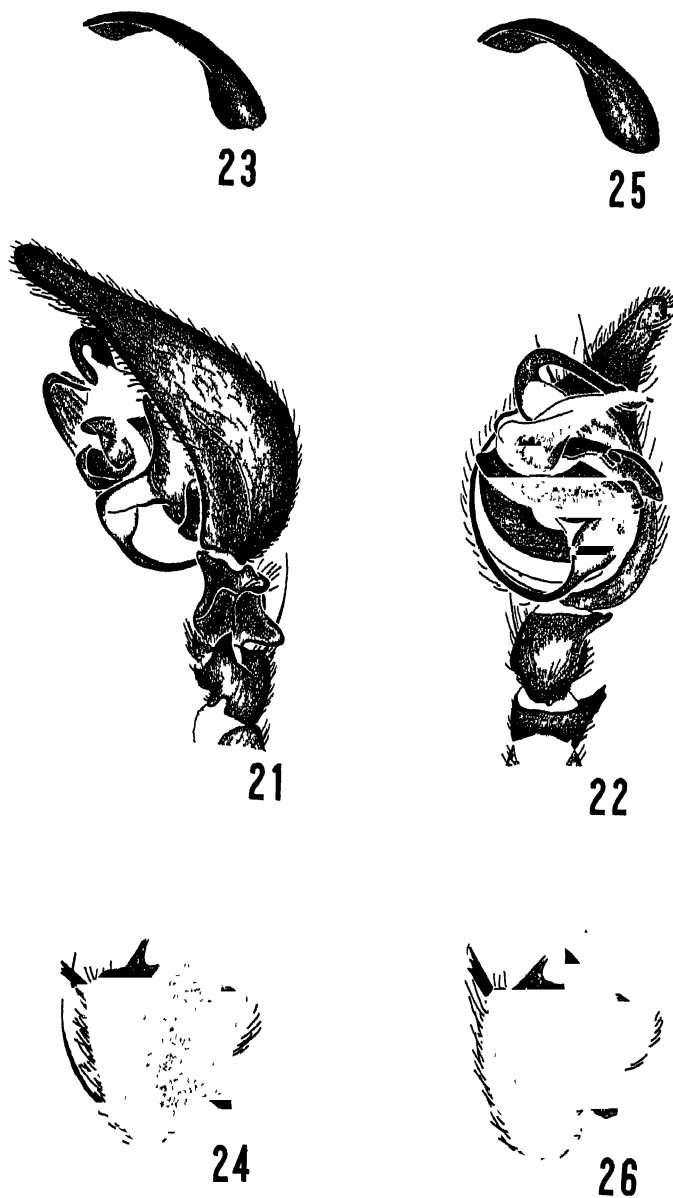


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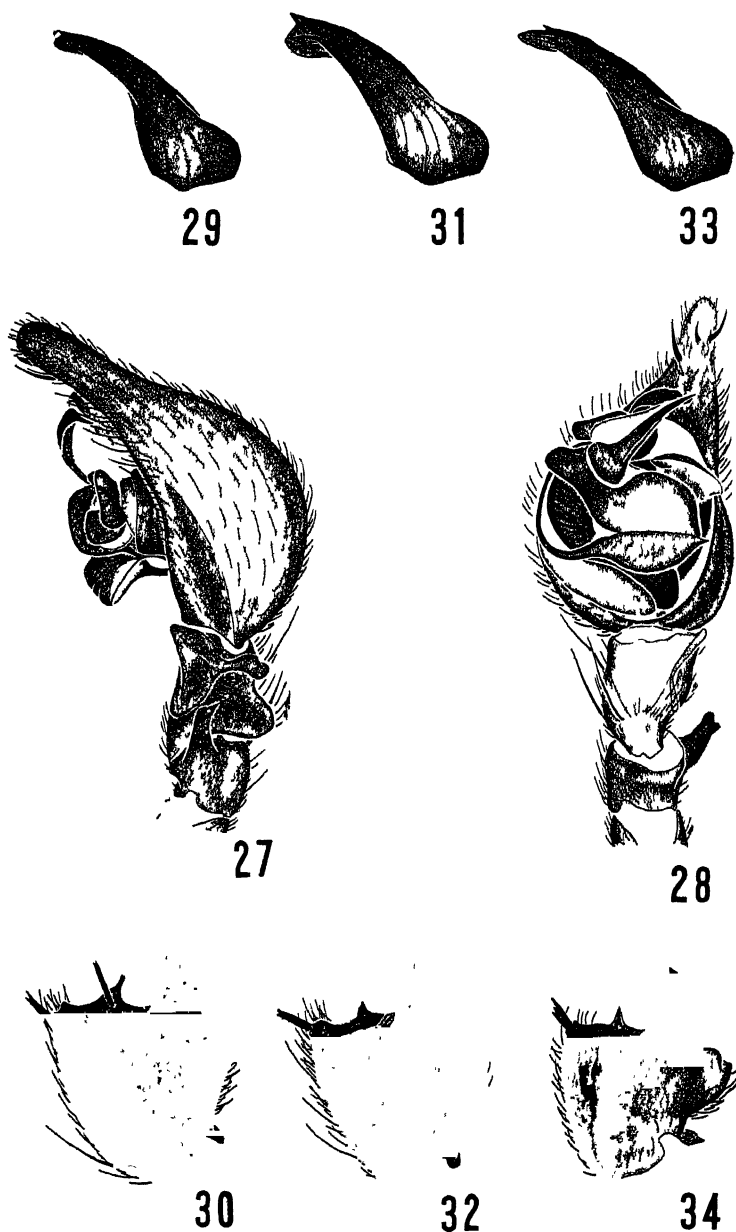


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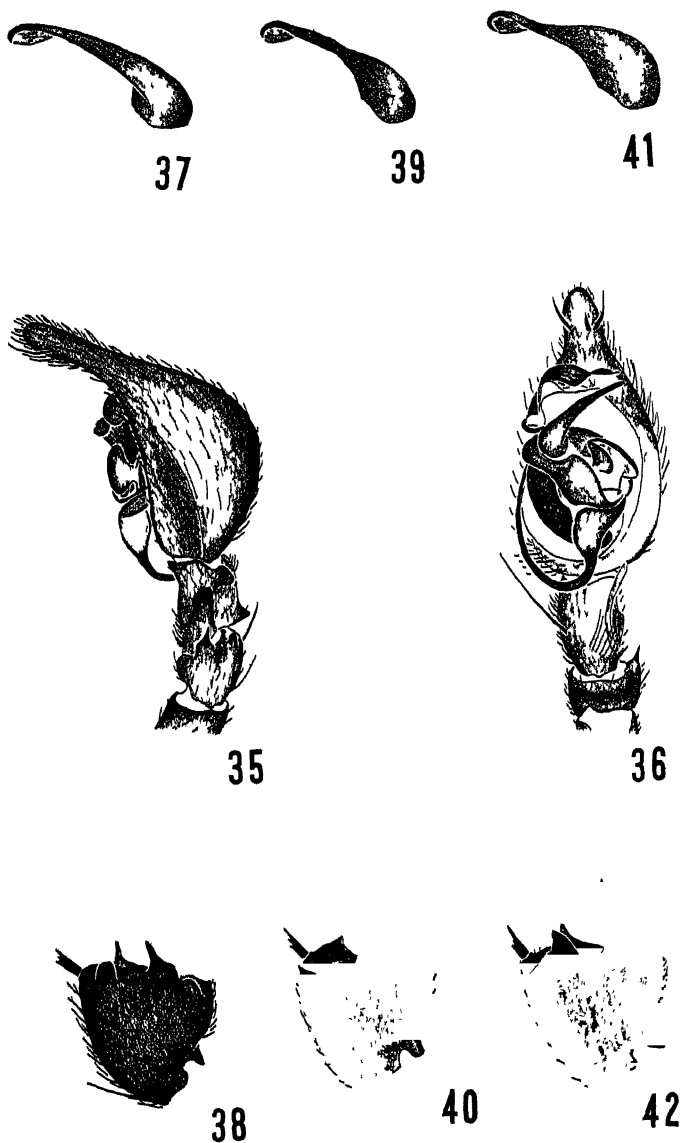
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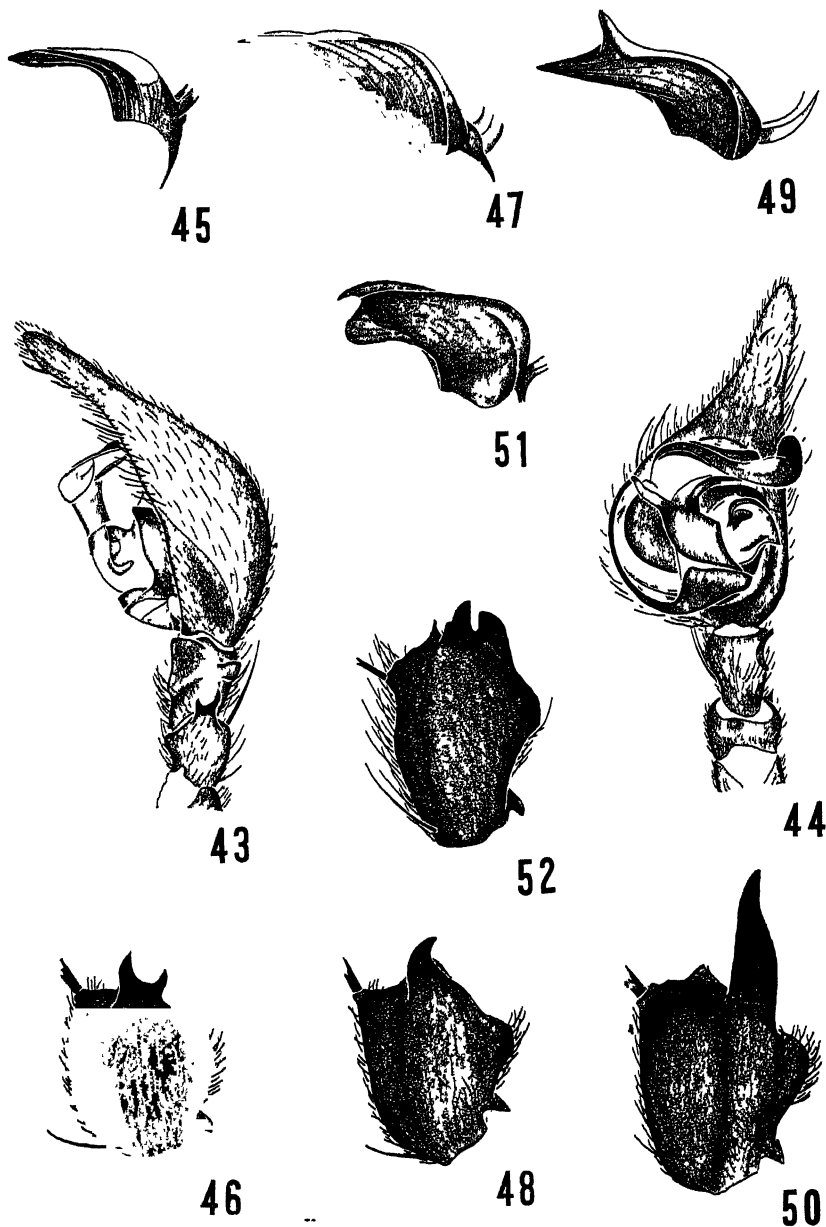
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AMERICAN MUSEUM NOVITATES

NUMBERS 1330 TO 1370



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THE AMERICAN MUSEUM OF NATURAL HISTORY
New York City

February 11, 1947

NEW SPECIES AND SUBSPECIES OF NEOTROPICAL HESPERIIDAE
(LEPIDOPTERA, RHOPALOCERA)

BY ERNEST L. BELL

The specimens from which the following descriptions are made are all contained in the collection of the American Museum of Natural History.

Where reference is made to the venation of the wings by number, it follows the English system of numbering the veins of each wing from the lowest vein upward.

The measurements of wing expanse are twice the distance from the center of the thorax to the apex of one primary wing.

***Pyrrhopyge evansi*, new species**

MALE

The upper side of both wings is bluish or greenish black, the under side black with a bluish or greenish sheen. The secondaries have a white basal band of variable width but usually narrow. The fringes of both wings are white on both sides, those of the primaries darkened at and just before the apex, those of the secondaries darkened at the outer angle.

The head, collar, palpi, and anal tuft are red. There is a round black spot in the center of the front of the head and a short black stripe in front of each antenna. The pectus is blue black. The antennae are black.

EXPANSE: 54 to 60 mm.

TYPE MATERIAL: The holotype male is from Muzo, Colombia. Paratypes: eight males, three of which are from Colombia, four from the Canal Zone, Panama, one each from Corozal, Fort Sherman, Ancon and Gatun Lake, and one from French Guiana.

This species is named for Brigadier William H. Evans of the British Museum who has done so much valuable work with the Hesperiidæ.

It is this species that was long considered

to be *Pyrrhopyge phidias* Linnaeus until Evans (1940, p. 405) proved that the species of Linnaeus is another insect without the white basal band on the under side of the secondaries.

Pyrrhopyge sergius bolius,
new subspecies

MALE AND FEMALE

This subspecies differs from *Pyrhopyge sergius sergius* Hopffer from Peru in the entire absence of the bluish white marginal band on the underside of the secondaries.

EXPANSE: Male, 54 mm.; female, 64 mm.

TYPE MATERIAL: The holotype male bears the label "R. Chimato, Boliv. Apr. 12 26, 1900 f.," and the allotype female bears the label "Buenavista, Dept. of Santa Cruz, Bolivia, 400 meters." Paratypes: two males with the same locality data as the holotype.

The male genitalia are the same as those of *Pyrrhopyge sergius sergius* Hopffer. Inasmuch as several species of *Pyrrhopyge* appear in superficially identical, or nearly identical, forms, so that it is impossible to formulate external characters that will always accurately separate them, recourse will have to be made to an examination of the male genitalia to identify them.

Pyrrhopyge sergius ganus,
new subspecies

MALE

This subspecies differs from *Pyrrhopyge sergius sergius* Hopffer in the extreme reduction of the bluish white marginal band on the under side of the secondaries. In typical *sergius* from Peru the marginal band is several millimeters wide in the

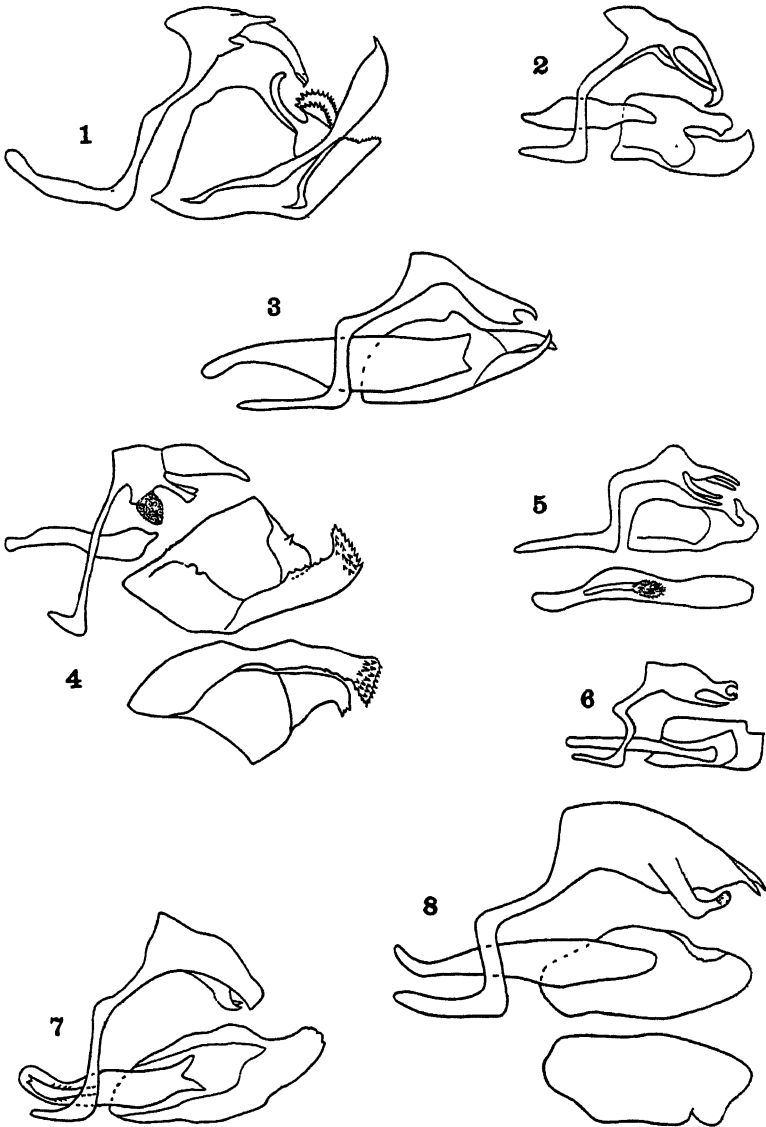


Fig. 1. Male genitalia, *Pyrrhopyge excelsus*.
 Fig. 2. Idem, *Quadrus eboneus*.
 Fig. 3. Idem, *Mnestheus lotus*.
 Fig. 4. Idem, *Eracon zita*.
 Fig. 5. Idem, *Euroto campo*.
 Fig. 6. Idem, *Artines montes*.
 Fig. 7. Idem, *Eutocus bocus*.
 Fig. 8. Idem, *Perichares zikani*.

widest part, and in the specimen from British Guiana here described it is barely 1 mm. wide.

EXPANSE: 58 mm.

TYPE MATERIAL: The holotype male is labeled "British Guiana."

The male genitalia are the same as those of *Pyrrhopyge sergius sergius* Hopffer except that there is a noticeable swelling in the basal half of the long rod-like flanges that project forward from the base of the uncus.

***Pyrrhopyge amythaon peron*,
new subspecies**

This subspecies differs from *Pyrrhopyge amythaon amythaon* Bell in having a white basal band on the under side of the secondaries. The white band is usually moderately broad and regular in formation but in one specimen (the Bolivian paratype) it starts with a small spot above vein 8 and is less broad and a little irregular.

EXPANSE: Male, 54 to 62 mm.; female, 64 mm.

TYPE MATERIAL: The holotype male and allotype female are from Iquitos, Peru. Paratypes: five males, one each from Iquitos, Peru, northeastern Peru, and Yumbatos, Peru, one from Colombia, and one from "R. Chimato, Bolivia, April 12 26, 1900 f."

The only specimen of *Pyrrhopyge amythaon amythaon* Bell we have seen is the holotype male from Pernambuco, Brazil, which has the under side of the secondaries entirely lacking the white band. Pernambuco, Brazil, is located on the eastern side of South America, and all of our specimens of the subspecies *peron* are from the western side of the continent. The male genitalia of *amythaon peron* are the same as those of *amythaon amythaon*.

***Pyrrhopyge rileyi orientis*,
new subspecies**

MALE AND FEMALE

This subspecies differs from *Pyrrhopyge rileyi rileyi* Bell in having a broad, bluish white marginal area on the upper side of the secondaries and a very broad basal area of the same color on the under side of

these wings and in having a black collar. Typical *rileyi* has no white area on either side of the secondaries, and the collar is carmine.

The bluish white areas of the secondaries of *orientis* are of the same form as that found in the insect Hübner described as *Pyrrhopyge hyperici*.

EXPANSE: Both sexes, 54 mm.

TYPE MATERIAL: The holotype male and the allotype female are from Pará, Brazil.

The male genitalia are the same as those of *Pyrrhopyge rileyi rileyi* Bell.

***Pyrrhopyge draudti lina*,
new subspecies**

MALE AND FEMALE

This subspecies differs from *Pyrrhopyge draudti draudti* Bell in having a bluish white marginal area on the upper side of the secondaries and a very broad basal area of the same color on the under side of these wings. These bluish white areas are of the same general form as those found in the insect which was described by Hübner as *Pyrrhopyge hyperici*.

EXPANSE: Male, 44 mm.; female, 54 mm.

TYPE MATERIAL: The holotype male and the allotype female are from Pará, Brazil.

This subspecies is named for Miss Lina Sordillo of the American Museum of Natural History.

The male genitalia are the same as those of *Pyrrhopyge draudti draudti* Bell.

Evans (1941, p. 21) has noted that several species of *Pyrrhopyge* occur in the *hyperici* form of maculation in the Pará region of Brazil.

***Pyrrhopyge excelsus*, new species**

Figure 1

MALE

The upper side of both wings is shining greenish black. The fringes of the primaries are white. At the anal angle of the secondaries the fringes are red, and there is a narrow border of this color on the wings themselves, as far as vein 2; above this point the fringes are white.

On the under side the wings are the same color as above; the inner margin of the primaries is a little paler. At the anal angle of the secondaries the narrow red border of the wings is of a paler shade.

The thorax and the abdomen are greenish black on both sides. The anal tuft is brown. The head is black with white spots before and behind the eyes. The collar is black with a thin white line. The patagia and the tegulae are greenish black. On the under side the palpi are brown at the base, becoming darker at the apex and with a slight bluish reflection. The pectus is greenish black. The antennae are black. The legs are dark brown with a bluish reflection.

EXPANSE: 58 mm.

TYPE MATERIAL: The holotype male is from Londrina, State of Paraná, Brazil.

In superficial appearance *excelsus* resembles *Pyrrhopyge agenoria* Hewitson and *stylx* Möschler but differs from both of these species in lacking any red on the head or anterior part of the body, in having more extensive red fringes at the anal angle of the secondaries, and less red on the wings themselves.

The form of the male genitalia is very different from that usually found in the group of *Pyrrhopyge* to which *excelsus* seems to belong on the superficial characters. The uncus is long and tapering, with a short, rounded flange from the base on each side. The claspers are symmetrical, and they are sharply slanted upward a little beyond the outer half of the ventral edge and terminate in a pointed apex. On the dorsal edge from the apex to a short distance behind it there are numerous short serrations, and then there rises a broad lobe with larger serrations; immediately behind this lobe rises a long, slender arm, curved forward. On the inner side of the claspers is a long arm which extends upward far above the dorsal edge, passing it at a point between the apex of the claspers and the serrated lobe behind it. From its base this arm rapidly narrows in width to about the dorsal edge of the claspers and then widens again, and at the apex terminates in a short, sharply pointed hook.

Eracon zita, new species

Figure 4

MALE

The upper side of both wings is brown; the fringes are concolorous. The primaries have a large dark brown spot near the end of the cell and a small one immediately beneath it, a discal band of irregular dark brown spots from the costal margin, curving around the end of the cell, to the inner margin, and a submarginal band of smaller dark brown spots. The two bands nearly merge opposite the end of the cell. There is a scattered overscaling of sordid whitish.

The secondaries have submarginal, discal, and subbasal bands of dark brown spots and two other spots of the same color, one basal and the other below the end of the cell where it nearly connects the discal and subbasal bands.

On the under side the wings are a little paler brown than above. The inner margin of the primaries is paler than the rest of the wings; the bands of the upper side are repeated but somewhat less defined.

The secondaries have the dark bands of the upper side repeated but they are narrower and paler, the basal spot is absent, and the discal and subbasal bands are not nearly connected below the cell. From vein 7, widening downward, there is an overscaling of bluish white, heaviest at the anal angle, and in the end of the cell where they accumulate to form a bar. The abdominal fold has long bluish white hairs.

On the upper side the head is brown with a few whitish scales intermixed in the front; the thorax and abdomen are brown. On the under side the thorax and abdomen are bluish gray; the palpi have white, bluish, and brown scales intermixed; the legs are brown with some bluish hairs. The antennae are black on the upper side and are paler on the under side, with the club yellowish brown and the apiculus reddish at the side.

There is no costal fold on the primaries, no hair tuft on the base of the secondaries, and no hair tuft on the hind tibiae.

EXPANSE: 38 mm.

TYPE MATERIAL: The holotype male is from the Itatiaya Mountains, Campo

Bello, State of Rio de Janeiro, Brazil (J. F. Zikan).

In superficial appearance *zita* resembles *Eracon duidae* Bell, but it is slightly larger and has the bluish white overscaling on the under side of the secondaries which *duidae* lacks. The form of the male genitalia is very similar in the two species but the details differ sufficiently to separate them. As is the case with *duidae* it is not certain that *zita* is strictly congeneric with the type of *Eracon*.

***Quadrus eboneus*, new species**

Figure 2

MALE

The upper side of both wings is black and the fringes are concolorous.

The under side of the wings is dark brown and paler toward the outer margin. The primaries have an indication of a subapical spot in interspace 8. The secondaries have a pale bar across the end of the cell. The fringes of both wings are black.

The upper side of the head, thorax, and abdomen is black. There is a narrow yellow line before the palpi. The under side of the thorax and abdomen is dark brown; the palpi are brown with sordid yellowish scales intermixed. The antennae are black on both sides; the club is yellow brown beneath. The legs are brown, the hind tibiae with a hair tuft and presumably two pairs of spurs, but only one of the upper pair is visible and that one is small.

EXPANSE: 38 mm.

TYPE MATERIAL: The holotype male is from Ojo de Agua, Vera Cruz, Mexico, June 12, 1941 (F. M. Brown).

This entirely dark-colored species will not likely be confused with any of the present members of the genus. The form of the male genitalia is very similar to that of *Quadrus zera* Butler, but in superficial appearance the two species have nothing in common.

***Euroto campo*, new species**

Figure 5

MALE

The upper side of both wings is brown. The primaries have a discal band of three spots and one minute subapical spot. The

discal band is composed of a very small, pale yellow spot a little beyond the center of vein 1; a white hyaline, quadrate spot a little excavate on the outer side, in interspace 2; a smaller white hyaline, quadrate spot in interspace 3. The fringes are brown, slightly paler at the tips. The stigma is a short triangular patch in the base of interspace 2 and an inconspicuous, short, horizontal bar beneath it below vein 2.

The secondaries have a faint trace of a discal band of small spots. The fringes are as on the primaries.

The under side of both wings is brown, paler than on the upper side. The primaries have the apical and upper half of the outer marginal areas suffused with pale violet. The veins crossing the violet area are very pale. The subapical spot and discal spots are repeated.

The under side of the secondaries, except the abdominal fold, are entirely suffused with pale violet and the veins are still paler. There is a discal band of four small, ill-defined, white spots in interspaces 2 to 4 and 6, the two lower spots the larger, the two upper spots barely visible.

The upper side of the head, thorax, and abdomen is brown with some fulvous hairs intermixed on the head and the top of the palpi. There is a reddish spot at the side of the eyes. On the under side the palpi are gray and brown intermixed, the pectus and thorax are grayish white, the abdomen is gray with some brown intermixed and with a brown central line. The antennae are black on both sides; the club on the under side is paler at the base.

FEMALE

Similar to the male. On the upper side of the primaries there is no subapical spot visible; the spots of the discal band are a little larger than in the male, that in interspace 2 inwardly angled. The secondaries have the lower two spots of the discal band a little plainer than in the male.

On the under side of the primaries the violet suffusion is a little more extensive, and the veins in the apical area are pale brownish. On the secondaries the veins are sordid white and strongly contrast with

the violet suffusion. The discal band consists of six white spots in interspaces 1 to 6, those in interspaces 1 and 5 being very minute; the other four spots are a little larger than those of the male.

EXPANSE: Male, 34 mm.; female, 38 mm.

TYPE MATERIAL: The holotype male is from the Itatiaia Mountains, Campo Bello, State of Rio de Janeiro, Brazil, and the allotype female is from the same locality (J. F. Zikan).

The hyaline spots of the primaries are much larger than those of *Euroto compta* Butler or *micythus* Godman and more quadrate than those of *sylvia* Kaye. In the male genitalia the termination of the claspers is quite different from that found in other closely allied species of the genus.

Eutocus bccis, new species

Figure 7

MALE

The upper side of both wings is brown, the fringes are slightly paler. The primaries have a conspicuous sagittate stigma in the base of interspace 2.

The under side of the primaries is rufous brown; there is an outer marginal band of small dark dots between the veins and a submarginal band of similar dots as far down as just below vein 3. There is reddish fulvous scaling on the costal margin and on the outer margin down to vein 5.

The under side of the secondaries is rufous brown. There is an irregular, paler central spot which extends from the abdominal fold to vein 8, an irregular subbasal dark area, the base itself pale; outwardly from the pale central spot is a curved band of broad dark spots with paler centers extending from the abdominal fold to vein 8 and each spot as wide as the interspace in which it lies; this band is followed outwardly by another pale area and a marginal band of dark dots.

The upper side of the head, thorax, and abdomen is brown. On the under side the palpi, pectus, and thorax are brown intermixed with fulvous; the abdomen is brown intermixed with paler hairs. The antennae are black on both sides, lightly spotted with

paler color on the under side; the club, and just below it, is yellow brown.

EXPANSE: Male, 38 mm.; female, 40 mm.

TYPE MATERIAL: The holotype male is from the Itatiaia Mountains, Campo Bello, State of Rio de Janeiro, Brazil, and the allotype female is from the same locality. Paratype: one female from the same locality as the type and allotype (J. F. Zikan).

The larger size of this species distinguishes it from the other present members of the genus.

Artines montes, new species

Figure 6

MALE

The upper side of the primaries is dark brown; the costal margin except at the apex, the base of the wings, and the inner marginal half are fulvous. There are four fulvous subapical spots, that in interspace 8 very small, that in interspace 7 a little larger, that in interspace 6 the largest, that in interspace 5 very small. There is a discal band of four fulvous spots, that in interspace 1 a long narrow streak, that in interspace 2 semihyaline, elongate, and angled to a point inwardly, that in interspace 3 semihyaline, an elongate triangle, that in interspace 4 a narrow streak. The fringes are brown and whitish at the tips. There is a sagittate stigma filling all of the base of interspace 2 to the spot of the discal band.

The secondaries are dark brown. There is a broad fulvous discal area cut into four spots by the black veins. There are long fulvous hairs at the base of the wings and along the abdominal fold. The fringes are fulvous at the anal angle and above there are brown with paler tips. There is a long black hair tuft in the abdominal fold.

On the under side the primaries are fulvous in the upper part of the cell, on the costal margin, and in the apical area; the rest of the wings is black. The two larger subapical spots are repeated, and there is an indication of the one in interspace 5. The discal spots in interspaces 2 to 4 are repeated, and in the paratype there is a small fulvous streak in the cell just behind the spot in interspace 2.

The under side of the secondaries is pale fulvous brownish. There is a yellow central area corresponding to the fulvous discal area of the upper side, but it is not divided into spots by the veins. Just outside the end of the cell is a small black spot and in some individuals indications of another one in the end of the cell. There is a submarginal band of from four to five small dots which are either black or dark fulvous brown; they are ill defined and sometimes tend to be elongated outwardly toward the margin of the wings. The abdominal fold is blackish brown.

The top of the head, thorax, and abdomen is fulvous and fulvous brown intermixed. On the under side the palpi are fulvous and fulvous brown intermixed, the thorax is fulvous, the abdomen is fulvous with a dark central line. The antennae are black on both sides, spotted with fulvous brown on the under side.

FEMALE

Similar to the male but with less fulvous on the primaries.

EXPLAN: Male, 26 to 28 mm.; female, 26 mm.

TYPE MATERIAL: The holotype male is from the Itatiaia Mountains, Campo Bello, State of Rio de Janeiro, Brazil, and the allotype female is from the same locality. Paratype: one male from the same locality as the type and allotype (J. F. Zikan).

This species is most nearly related to *Artines perpulcher* Hayward and *Apaustus argynnis* Plötz and has the same form of stigma on the primaries and hair tuft on the secondaries as they have, but it is readily distinguished by the details of the maculation. Other species having a somewhat similar superficial appearance to *montes* are *Artines fastus* Hayward, *Padraona argus* Draudt, and *Apaustus odilia* Plötz, but these three species lack the hair tuft on the secondaries. It is probable that *montes* is not strictly congeneric with the type of *Artines*, but for the time being it is placed in that genus where some of the other species mentioned above have been placed by previous authors.

Mnestheus lotus, new species

Figure 3

MALE

The primaries on the upper side are dark brown at the apex and have a broad outer marginal band, a stripe in the cell which widens from the base outward, a dash below the cell in interspaces 4 and 5 and reaching the marginal band in interspace 5 but not in 4, a stripe below the cell in interspace 1 extending to the rise of vein 2 where it is divided into two short arms, the upper arm extending into interspace 2, all of which are dark brown. The rest of the wings are fulvous, and this color cuts a small notch into the dark brown stripe in the cell just behind the base of interspace 3. The fringes are dark brown with fulvous at the tips. There is no visible stigma.

The secondaries have a broad, irregular, fulvous discal band which extends to the base of the wings in a narrow stripe, and there is another fulvous stripe along the edge of the abdominal fold. There may be two small black dashes in the fulvous discal band, or these may be absent. The costal and outer margins and the abdominal fold are dark brown. The fringes are as on the primaries.

On the under side the primaries are fulvous with the costal, outer margin narrowly, and the lower half of the extreme base, dark brown. There is a submarginal band of elongate spots in each interspace from 1 to 8, two contiguous stripes outward from the end of the cell, four short stripes above the end of the cell, two small stripes about the lower center of the cell, a long, slightly downward-curved stripe in interspace 1 from the base, and a small spot in interspace 2 near the base, all of which are dark brown. The fringes are as on the upper side but crossed by dark brown at the end of the veins.

The secondaries are dark brown on the under side. All of the veins are broadly margined with fulvous which cuts the dark brown ground color into three series of elongate spots, forming submarginal, discal, and basal bands. Two of these dark brown spots are extremely long, one above

vein 8 extends from the base of the wings almost to the outer margin, the other one from near the base of the wings entirely through the cell and most of interspace 5 where it is but narrowly separated from the submarginal band. The fulvous area between the submarginal and discal bands of dark brown spots appears as an angled band of fulvous spots extending from the abdominal fold to vein 8, behind which there is a small fulvous spot near the end of the cell. The costal and outer margins are narrowly dark brown. The abdominal fold is dark brown sprinkled with fulvous scales. The fringes are as on the upper side.

On the upper side the head, thorax, and abdomen are fulvous, the abdomen ringed with dark brown. The third joint of the palpi is erect, very long, slender, and sharply pointed. On the under side the palpi, pectus, thorax, and abdomen are fulvous. The antennae are black on both sides, the under side spotted with fulvous, the club fulvous.

EXPANSE: 22 to 24 mm.

TYPE MATERIAL: The holotype male is from the Itatiaia Mountains, Campo Bello, State of Rio de Janeiro, Brazil. Paratypes: three males from the same locality (J. F. Zikan).

Although *lotus* lacks the usual stigma found on the primaries of other members of the genus *Mnecstheus*, it seems to be closely allied to them.

Perichares zikani, new species

Figure 8

MALE

The upper side of the primaries is brown, and the base of the wings below the cell is covered with long metallic blue hairs. There are five semihyaline yellow spots; one in the apex of the cell is comma-shaped with the tail of the comma directed inwardly; the other four form a discal band of which two spots are in interspace 1, one of them is triangular and lies on vein 1 and the other one is a narrow stripe outwardly above it slanting downward from vein 2; the third spot is large and irregular in shape and extends across interspace 2; the fourth

spot is in interspace 3 and is taller than wide. There is also a very small yellow spot between the cell spot and the costal margin. The fringes are concolorous. There is no stigma.

The secondaries are brown and have long metallic blue hairs on the base of the wings and along the abdominal fold. The fringes are yellowish white.

The under side of both wings is brown. The primaries are paler in the apical area and along the inner margin. The spots of the upper side are repeated, the spot on vein 1 is larger, and the spot above the cell spot fills all of the space to the costal margin. The secondaries have bluish hairs in the basal area and a narrow yellow marginal band from the outer angle almost to vein 1, widest at the outer angle and narrowing downward.

The top of the head, thorax, and abdomen is brown, the head with a faint bluish tinge and the tegulae with a more pronounced bluish tinge according to the angle of light in which it is seen, and there is some bluish hairing at the base of the abdomen. On the under side the palpi and pectus are gray brown, the thorax is brown with a bluish or greenish reflection, the abdomen is brown. The antennae are black on both sides, the club is fulvous beneath.

FEMALE

The wings are of a little darker brown ground color. The primaries have the same number of spots as the male, a little paler yellow and smaller except the spot in the upper part of interspace 1 which is a little larger; the cell spot is more U-shaped with the two arms pointing inwardly. In this sex the spots of the primaries form a band which appears to run from the costal margin toward the inner angle, whereas in the male the band appears to run from vein 1 toward the apex of the wings.

On the under side the apical area of the primaries is covered with small lilacine scales except on the outer margin. On the secondaries the outer marginal yellow band reaches to just below vein 1. Otherwise similar to the male.

EXPANSE: Male and female, 46 mm.

TYPE MATERIAL: The holotype male is from the Itatiaia Mountains, Campo Bello, State of Rio de Janeiro, Brazil, and the allotype female is from Londrina, State of Paraná, Brazil. Paratype: one female from Londrina, State of Paraná, Brazil (J. F. Zikan).

This handsome species is named for Prof. J. F. Zikan of Campo Bello, State of Rio de Janeiro, Brazil.

In superficial appearance *zikani* somewhat resembles *Perichares triplaga* Schaus, but the male of that species has only three semihyaline yellow spots in the band of the primaries and they are of a different shape, the fringes of these wings are yellow from just above vein 2 to the inner angle, and there is a stigma, and the under side of both wings is of a different color.

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AN EOCENE SERRANID FROM PATAGONIA¹

By BOBB SCHAEFFER

INTRODUCTION

The much-discussed problem of the origin or derivation of the fresh-water fish fauna of South America is still by no means solved. The importance of paleontology in this connection is obvious, and therefore any discovery of fossil actinopterygians in lacustrine-fluvial or even estuarine deposits on that continent is of particular interest. With the exception of those described from Brazil, Tertiary fresh-water fishes are virtually unknown from South America. It is hoped that this situation will be remedied by more intensive collecting.

In the spring of 1931 Dr. G. G. Simpson, while on the First Scarritt Patagonian Ex-

pedition, found the remains of percoid fishes. All the specimens appear to belong to the same genus and species, and a description of this collection forms the basis for this paper. The writer is greatly indebted to Dr. Simpson for the opportunity to study this material, for the use of his field notes, and for permission to include a sketch map and profile section of the pertinent portion of Cañadón Hondo, in which the fish were found.

The composite restoration was drawn by Mr. John C. Germann, the locating diagram and geologic section by Miss Marie Bohrn, and the photographs were taken by Mr. Elwood Logan.

¹ Publications of the Scarritt Expeditions, No. 36

GENERALIZED SECTION, CAÑADÓN HONDO

APPROXIMATE THICKNESS	EQUIVALENT IN MEASURED SECTION CF	NATURE	REMARKS
>100'	12, 12 ^a , 12 ^b	Green tuffs and clays. No fossils found	
		—Guide horizon—	
15'	11, top of III	Rather similar to above. No fossils	
15'	Bottom of III, top of 10	Also greenish tuff and clay	
		CASAMAYORAN MAMMALS	
65'	9 and bottom of 10, probably also II and top of I	Mainly bedded greenish clays with some beds of tuff	
10-15'	7 and 8	Rather thin-bedded, somewhat concretionary clays	
16'	6	Clays, thin-bedded below, more massive above	
6"	Bottom of 6, A in Section CF	Laminated shale	Fish are probably about 90' to 95' below Casamayoran mammals unless a fault intervenes
		FOSSIL FISH	
17'	5	Variegated clays	
5'±	4	Indurated tuff	
		—FAULT ² —	
		—Gap, relations uncertain ³ —	
50'+	1	Sand and clays	Probably Riochican

² It is assumed that no considerable faulting exists above this level.

³ Very dubious distorted glauconitic beds (3 in Section CF; see fig. 2) omitted.

DETAILS OF SECTION CF, CAÑADÓN HONDO

BED	THICKNESS	NATURE	REMARKS
1	50'+	Pale clays and soft, reddish, cross-bedded sandstones	Probably Riochican, and grades down into thick Riochican series in the lower part of the Cañadón
2	5'±	Greenish sandstone with clay pebbles	
3	50'+	Mostly bright green sandstone and clay, with some bright red patches. Glauconitic	These beds are heavily distorted and slumped. They may be quite out of sequence here. Resembles Salamancan
—NORMAL FAULT, THROW UNKNOWN—			
4 ¹	5'±	Irregular, indurated, pale green to white tuff with pink spots	
5	17'	Irregular varicolored clays	
6	16'	Clays. Thin-bedded, buff or white to greenish at bottom. Becoming more massive and irregular above and green with yellow seams and red spots	The fish are from buff, laminated clay or shale (probably with volcanic ash?) in the lowest 6" of these beds
7	10'	Clays and concretionary beds weathering brown or yellow	
8	10'	Very thin-bedded greenish and yellow clays, with some hard concretionary layers	This is in part, perhaps wholly, equivalent to 7, but may include some higher strata
9	45'±	Horizontally bedded green clays with some beds of white or greenish tuff	I, a thick series of green clays and tuffs, is probably horizontally equivalent to 9 and the bottom of 10
10	35'	Green clays, in part very thin-bedded and in part more massive. Some, but little, tuff	The lower 25' seem to be equivalent, at least in part, to the top 25' of 9. II, a rather massive green concretionary tuff, is probably horizontally equivalent to part of 10
11	15'	Pale green tuff and some green clay, mostly concretionary, weathering brown. At the top is a characteristic blue-green tuff with a basal concretionary layer weathering brown	Top bed is a good horizon marker and reappears in 11 ^a , above the mammals. III, an irregular coarse green tuff and tuffaceous clay, is probably equivalent to 11 and the top part of 10 and contains Casamayoran mammals in lower 15'
12	50'	Mostly obscure or unexposed, but some exposures of pale green clay and tuff	
12 ^a	20'	Thin-bedded pale green tuff with some green clay	This is simply the top 20' of 12, better exposed on this side of the hill
12 ^b	105'±	Thin-bedded pale greenish tuffs with some green clay. Some of the beds are silicified (opalized?) and sometimes have limonite nodules	

—TOP OF ROUGHLY CONTINUOUS SECTION FROM 4 TO 12—

¹ The clays are mostly, if not entirely, bentonitic in beds 4 to 12.

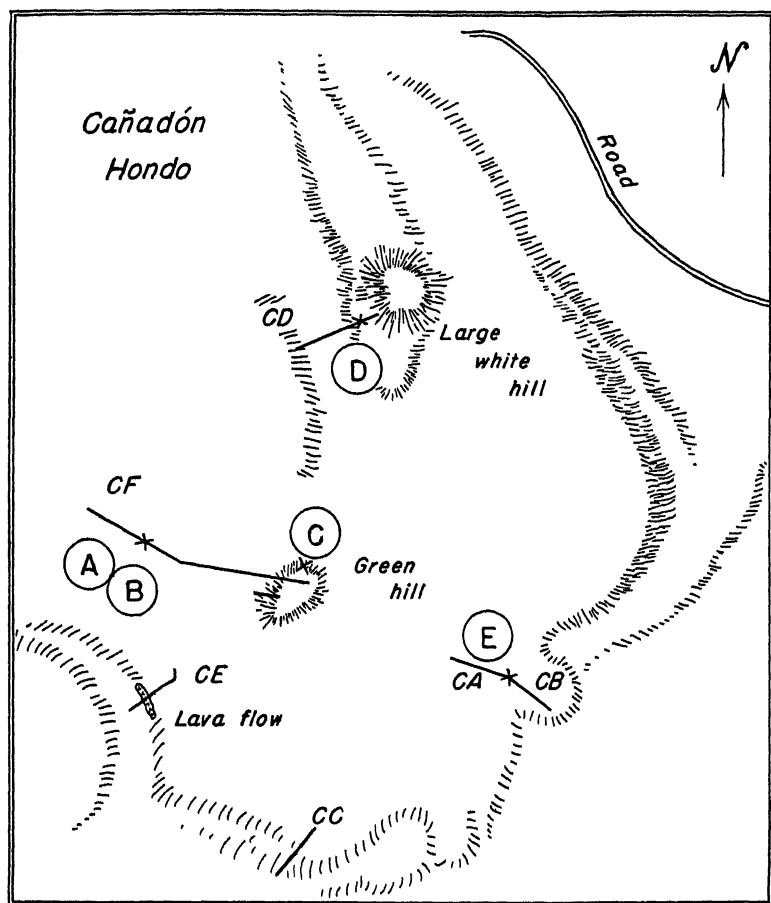


Fig. 1. Locating diagram of Cañadón Hondo. The Cañadón is a semicircular basin several miles across with an elevated rim at plateau level and an irregular floor with numerous ridges and hills, of which the two most prominent are shown. The vertically measured section including the "fish bed" (CF) is reproduced in figure 2. A represents the fish locality; B, an adjacent plant locality; C, Casamayoran mammal locality; D, Riochican mammal locality (Cañadón Hondo or *Kibenikhoria* faunule); and E, "Bird Clay" with anurans, birds, *Crossochelys*, *Sebecus*, and *Coöna* (mammal), believed to be Casamayoran, although the fauna is very distinctive.

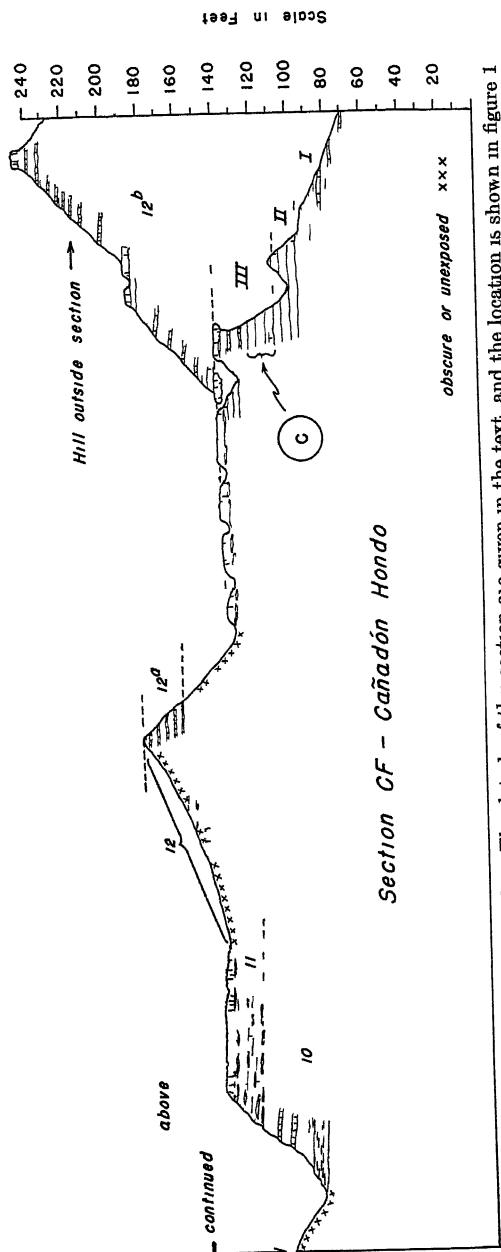
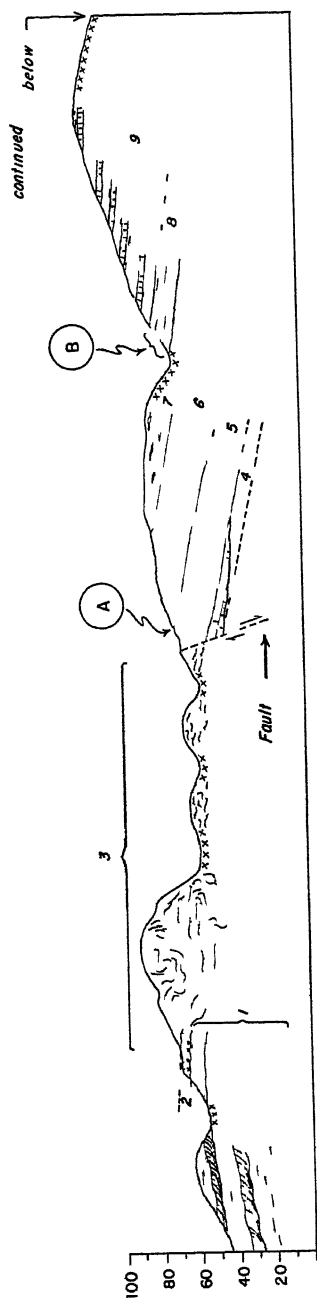


Fig. 2. Section CF, Cañadon Hondo. The details of this section are given in the text, and the location is shown in figure 1.

TAXONOMY AND DESCRIPTION

Family Serranidae

Percichthys hondoensis, new species

TYPE: A.M.N.H. No. 10000. Incomplete skeleton with anterior portion of skull and pelvic fin missing. Hypodigm consists of 23 fragmentary specimens from same locality.

HORIZON AND LOCALITY: "Fish bed," in the upper portion of Cañadón Hondo near a small elevation known as Monte Verde. The Cañadón ends at the right bank of the Río Chico near Paso Niemann and is about 65 kilometers northwest of Comodoro Rivadavia on the Golfo de San Jorge, territory of Chubut, Argentina. The Tertiary exposure in the Cañadón in which the fish remains were found is probably Casamayoran (Lower Eocene) in age. The "fish bed," composed of light brown finely laminated shales, probably represents a lacustrine deposit of volcanic ash. The geology of this area will be discussed by Simpson in a monograph now in preparation. It suffices to state here that the structure about Cañadón Hondo is very complex and obscure, with discontinuity of the important exposures, isolated lenticular beds, and a scarcity of mammalian fossils, making correlation practically impossible. There is reason to believe, however, that the beds can be reliably assigned to the Casamayoran.

DIAGNOSIS: Serranids of small size, ranging in the present sample from 2.45 to about 10.0 cm. in standard length. Skull somewhat less than one-third total body length. Mouth moderate, protractile. Posterior border of preopercular serrated. Opercular scaled, with single spine. Branchiostegals 6-7. Vertebrae 24-26: abdominal 10-11, caudal 14-16. Dorsal fin IX-X, 12, apparently not divided; pectoral fin 14; pelvic fin with one spine, number of rays unknown; anal fin III, 7-8. Origin of pelvic fins below and about opposite origin of pectorals, origin of dorsal fin slightly anterior to that of pelvic, origin of anal fin about opposite beginning of rayed portion of dorsal. Scales small, finely ctenoid.

DESCRIPTION: The proportions of the skeleton are very similar to those of the Recent *Percichthys melanops*, an X-ray of which is figured by Eigenmann (1927, pl. 13). Because of the fewer abdominal vertebrae, however, the abdominal region is relatively shorter, causing the dorsal and anal fins to be closer to the skull than in the Recent species. The head is between one-third and one-fourth of the standard length and the greatest depth about one-third of that length. The orbit is relatively large, about one-fourth of the skull length including the opercular.

The skull is poorly preserved in all of the available specimens, and most of the details cannot be determined. The premaxillary and maxillary are typically percoid with the lower end of the maxillary expanded to about the same extent as in *P. trucha*. There is a possible indication of a supplementary maxillary in one specimen, but this is not certain. The posterior border of the dentary is deeply notched as in the Recent species of this genus, with the apex of the notch closer to the dentigerous border than the ventral border. The jaws are definitely protractile and the suspensorium is forwardly directed. The serrations on the vertical limb of the preopercular are very fine, about 25 to 30 in number, while the spines on the horizontal portion are much larger but their number cannot be determined. In agreement with all other members of this genus, the opercular ends in a spine. There is a definite indication of villiform teeth on the jaws, but their presence on the vomer and palatine cannot be ascertained.

The centra are very similar to those of *P. antiquus* (Woodward, 1898, and Schaeffer, in press) from the Tertiary of Brazil, in fact typically percoid. The neurapophyses are delicate, as are also the ribs and haemapophyses.

The spines of the dorsal, pelvic, and anal fins are robust and large, while the rays of these fins are delicate and usually poorly preserved. The second interhaemal is typically heavy and elongate. The first anal

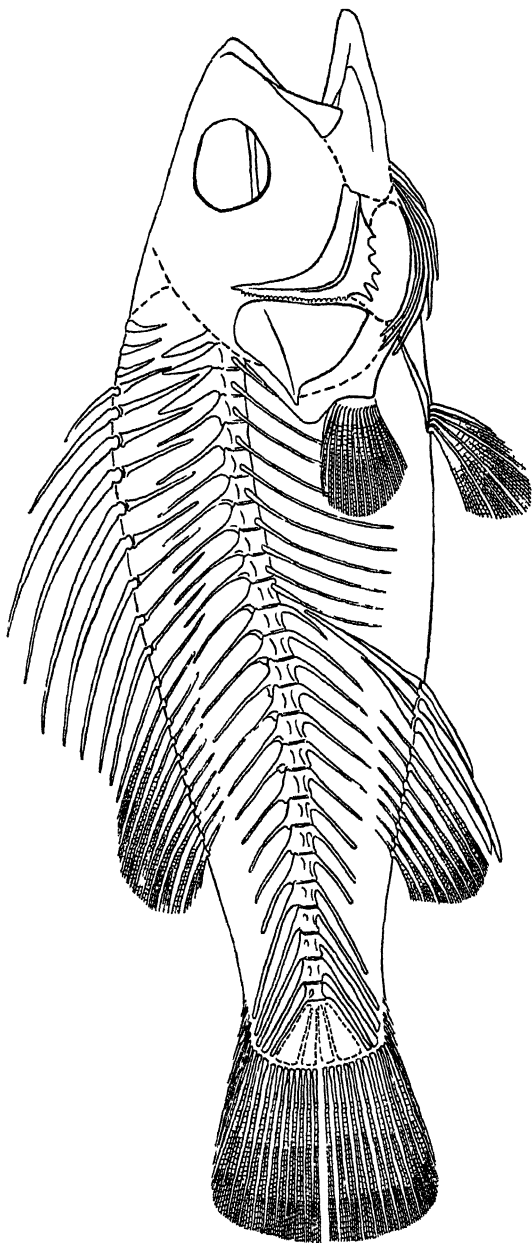


Fig. 3. Composite restoration of *Percichthys hondoensis*, based mainly on the specimens illustrated in the following figure. The outlines of the dermocranial elements cannot be determined.



Fig. 4. *Percichthys honabensis*. A, A.M.N.H. No. 10002, anal spine and caudal fin completely preserved, $\times 3/2$. B, A.M.N.H. No. 10003, $\times 3/2$. C, A.M.N.H. No. 10001, $\times 3/2$. D, A.M.N.H. No. 10005, opercular spine and serrated preopercular spine are present in this specimen, $\times 1$. E, Type, A.M.N.H. No. 10000, $\times 1$. F, A.M.N.H. No. 10004, showing maxillary and pinnaxillary in position, $\times 2$.

spine is the shortest of the three; the second and third are about of equal length.

The caudal fin is truncate or slightly rounded. Each lobe has about 12 rays.

DISCUSSION

Two genera of fresh-water serranids are known to occur in South America: *Percichthys* in Chile, Patagonia, and the ?Pliocene of Brazil, and *Percilia*, occurring at the present time only in Chile and unknown in the fossil state. According to Boulenger (1895) and Eigenmann (1927), these genera may be separated by the presence, in *Percichthys*, of a supplementary maxillary, dentigerous palatines, and small scales. *Percilia* lacks the supplementary maxillary, the palatine is smooth, and the scales are large.

It is unfortunately not possible to determine the nature of these differentiating characters in any of the specimens of *Percichthys honoensis*. Scale impressions are preserved in one specimen, and the scales appear to be relatively smaller than those of *Percilia*. As pointed out above, there is an indication of a supplementary maxillary in another individual. Assignment of this new species to *Percichthys* therefore appears indicated and is further supported by the fact that its previously known geological range runs back at least to the Pliocene and possibly earlier.

The Recent and later Tertiary species of *Percichthys* have between 32 and 35 vertebrae, while *P. honoensis* has but 24 to 26. The smaller number of vertebrae in this species is the one observable character that distinguishes it from the other members of the genus. Taken by itself, this difference can hardly be considered to be of generic rank, as a variation of 10 in the total number of vertebrae is by no means uncommon in other acanthopterygian genera. From the standpoint of the time factor alone, however, the question arises as to the validity of assigning percoid species ranging from the Lower Eocene to the Recent to the same genus, particularly since the percoids, during this period, were undergoing an accelerated and diversified radiation. The answer to this problem appears to be the paleontological record itself. In spite of the fact that the percoids were evolving

very rapidly during the Tertiary, there is ample evidence that a number of genera that appeared in the Eocene have persisted to the present time. *Perca*, *Centropomus*, *Lates*, *Serranus*, *Labrus*, and others fall into this category.

Woodward states (1901, p. xii) that the Eocene percoids indicate less differentiation than exists in this group at the present time. This opinion, which is certainly justified, is reflected in his broad usage of the family Percidae, including extinct genera now considered to belong to the Percidae, Centropomidae, and Serranidae (see Romer, 1945). Most of the characters that are used to separate, for instance, the Serranidae from the Percidae are very difficult or impossible to observe in fossils, and for this reason the assignment of a fossil form to one or the other family is often quite arbitrary. As *Percichthys* has been placed by various authors in both the Serranidae and the Percidae, a consideration of certain characters which distinguish these families appears desirable. The Percidae, fossil or recent, are unknown in the Southern Hemisphere. To consider *Percichthys* a member of this family (Romer, 1945), even if tenable on the basis of its morphology, would present another very baffling distributional problem as the perches have apparently been a fresh-water group as far back as the Eocene.

All Recent serranids have three anal spines while the percids have but one or two. As the number of these spines can usually be observed in fossil percoids, it has been used extensively in placing fossil forms in one family or the other. The presence or absence of a subocular shelf, occurring only in the serranids, can but very rarely be determined. The supplementary maxillary, absent in the Percidae, may or may not be present in the Serranidae; thus its presence does indicate serranid affinity but its absence means nothing conclusive. The occurrence of one or more spines on the opercular and the serration of the posterior

border of the preopercular are highly variable characters in both families and are hence of little diagnostic value.

In both the Serranidae and Percidae the total number of vertebrae in the Eocene genera is 25 or 26. Most of the Recent basses have 24 to 28 while a few genera have 35. The Recent perches have 30 to 48 vertebrae, representing a definite increase over the primitive number. The presence of 24 to 26 vertebrae in *Percichthys hondoensis* is hence a character shared in common with other Eocene members of both families and further supports the opinion that *Percichthys* is quite generalized and close to the common ancestor of the perches and basses. The primitive percoid formula was probably $10 + 14$ to $16 = 24$ to 26.

The Eocene serranid types include *Properca* (Sauvage, 1880), "*Labrax*," *Smerdis* (Agassiz, 1833), and *Cyclopoma* (Agassiz, 1833). These genera have the required three anal spines but are otherwise virtually indistinguishable from the Eocene types referred to the Percidae. *Anthracoperca* (Voigt, 1935) is considered to be a perch, although it has three anal spines and a sup-

plementary maxillary. *Amphiperca* (Weitzel, 1933) was described as a perch but also has three anal spines, and Romer (1945) has included it in the Serranidae. All these genera have seven to nine spines in the dorsal fin with a varying amount of subdivision into a first or second dorsal. The supplementary maxillary is apparently absent in most of them. The preopercular may or may not be serrated, and an opercular spine may or may not be present.

Percichthys hondoensis is obviously very similar to the other Eocene serranids but differs from the Eocene percids such as *Mioplosus* and certain species of *Perca* for the most part only in the number of anal spines.

The presence of *Percichthys* in the Lower Eocene of Patagonia further testifies to the antiquity of the South American freshwater fish fauna and indicates that this serranid gave up its marine habitus very early in its history. That *Percichthys hondoensis* is ancestral to *P. antiquus* and the Recent species of this genus is entirely possible, apparently the only requirement being an increase in the number of vertebrae.

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DERMACENTOR DISSIMILIS, A NEW SPECIES OF TICK FROM SOUTHERN MEXICO

By R. A. COOLEY¹

A new species of tick, *Dermacentor dissimilis*, from southern Mexico, is described from six females and two nymphal specimens received from Dr. W. J. Gertsch, of the American Museum of Natural History, New York City. Several attempts to obtain males have failed.

Dermacentor dissimilis, new species

Figures 1-10

FEMALE

BODY: Length, tips of palpi to tip of body (slightly fed specimen), 2.97²; width, 1.65. Oval, widest at about the middle. Fully fed specimens measure 10.00 in length by 7.00 in width, and are subelliptical in dorsal profile.

CAPITULUM: Length, tip of hypostome to tips of cornua, from 0.55 to 0.61. Width of basis, from 0.54 to 0.57. Porose areas oval, depressed, with their longer axes divergent anteriorly. Cornua rounded, about as long as wide. Punctations and hairs absent. In ventral view, basis is convex, posterior margin bluntly pointed. Inner faces of palpi mildly grooved longitudinally; article 3 with a mild retrograde spur.

HYPOSTOME: Of the six specimens, five have the denticles in a 4/4 pattern while one has it 4/3, and some have individual denticles out of line in the files (see fig. 3). Length, about 0.3.

SCUTUM: Length, 1.20 to 1.32; width, 1.10 to 1.14. Widest anteriorly, with mild lateral extensions, the eyes (when present) at the widest points. Posterolateral profile lines distinctly concave. Scapulae long, bluntly pointed. Eyes distinct, faint,

or absent. Cervical grooves wide apart, moderately deep. Punctations moderate in size and number. The dirty white color pattern variable in extent. The color visible in some specimens also on basis, palpi, dorsal surface of the legs.

LEGS: Trochantal dorsal spur on leg I, distinct, V-shaped. All tarsi and metatarsi about equal in length. Tarsus I with an apical ventral spur; II and III with apical and subapical spurs; IV with an apical and two subapical spurs. Length of tarsus I, 0.48; metatarsus, 0.36; or ratio of 1.0 to 0.75. Length of tarsus IV, 0.48; metatarsus, 0.39; or a ratio of 1.0 to 0.825.

COXAE: Coxa I bifid, the internal spur wider. Coxae II, III, and IV with distinct external spurs; internal spurs absent.

SPIRACULAR PLATE: Subcircular. Goblets few. Greatest dimension, about 0.33.

GENITAL APERTURE: Situated at the level of the intervals between coxae II and III.

NYMPH

BODY: No unengorged specimens available. Well-fed specimens measure 2.5 in length and 1.75 in width; oval in dorsal profile.

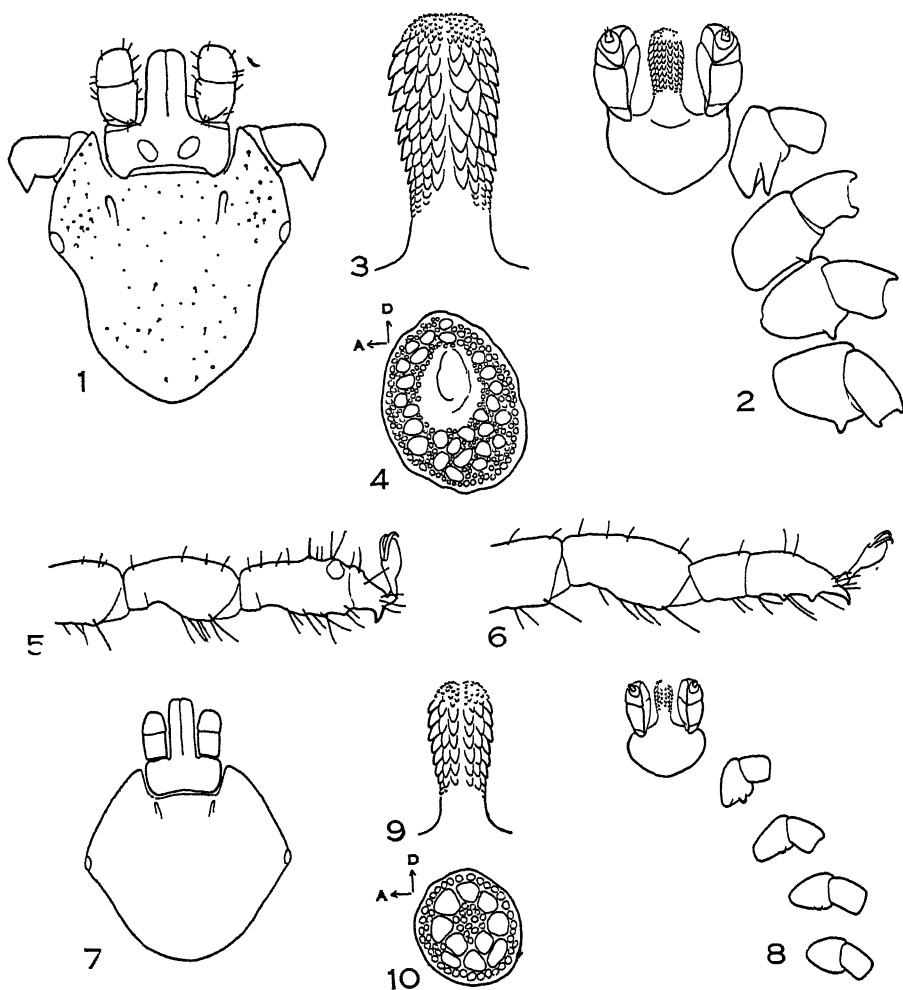
CAPITULUM: Length, tip of hypostome to posterior margin, 0.28; width of basis, 0.21. Basis short and wide, lateral points and cornua absent. Surface convex, punctations and hairs absent. In ventral view, basis is subreniform, convex; punctations and hairs absent. Ventral cornua absent (present in *D. albipictus*). Palpal article 1 visible as a very small convex plate.

HYPOSTOME: Short, broad. Dentition 3/3. Length about 0.16.

SCUTUM: Length, 0.51; width, 0.60. Broadly rounded behind, anterolateral

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² All measurements are in millimeters.



Dermacentor dissimilis, new species

- Fig. 1. Female capitulum and scutum, dorsum.
 Fig. 2. Female capitulum and coxae, venter.
 Fig. 3. Female hypostome.
 Fig. 4. Spiracular plate.
 Fig. 5. Female tarsus and metatarsus, leg I.
 Fig. 6. Female tarsus and metatarsus, leg IV.
 Fig. 7. Nymph capitulum and scutum, dorsum.
 Fig. 8. Nymph capitulum and coxae, venter.
 Fig. 9. Nymph hypostome.
 Fig. 10. Nymph spiracular plate. A, Anterior; D, dorsal.

sides nearly straight. Eyes distinct in both specimens. Cervical grooves short, moderately deep. Surface crazed, punctations few, faint; hairs absent.

COXAE: Coxa I with two short spurs, the internal one wider. Coxae II and III with short external spurs. Coxa IV with no spurs.

SPIRACULAR PLATE: Small, subcircular. Goblets few. Greatest dimension about 0.15.

MALE

Unknown.

Described and figured from six females and two nymphs taken from a horse, Las Margaritas, about 45 kilometers southeast of Comitán, Chiapas, Mexico, February 17, 1945. Collected by T. C. Schneirla.

Holotype female, two paratype females, and one paratype nymph are retained in the American Museum of Natural History. Other types are deposited as follows: one paratype female in the United States National Museum; two paratype females and

one paratype nymph in the Rocky Mountain Laboratory.

REMARKS

This interesting tick falls into the genus *Dermacentor*, although its inclusion requires some modification of the generic description. In some females the eyes are distinct, in one absent, and in some obsolescent and not easily found. The hypostome is particularly erratic in having the dentition formula $4/3$ in one specimen instead of $4/4$, and in others in having a few individual denticles large and out of alinement in the files.

The shape of the basis capituli (dorsal view) of this tick and the similarity of the spiracular plates suggest close relationship with *Dermacentor albipictus*, and since the adults and nymphs of *D. dissimilis* were collected simultaneously from the same horse, it is suggested also that this new species, like *D. albipictus*, may be a one-host tick.

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HYPENTELIUM ROANOKENSE, A NEW CATOSTOMID FISH FROM THE ROANOKE RIVER IN VIRGINIA

BY EDWARD C. RANEY AND ERNEST A. LACHNER

The Roanoke River system of Virginia is well known for its endemic fishes from the early ichthyological explorations of Cope (1869) and Jordan (1890) and the more recent studies of Raney and Lachner (1946c). Long overlooked in the small mountain streams of the upper headwaters is a dwarf species of hog sucker for which we propose the name.

Hypentelium roanokense, new species

Figure 1

DIAGNOSIS

A small *Hypentelium* adapted for life in swift water. Posterior fontanelle reduced to a slit, body heavy with foreshortened trunk, and posterior lobe of air-bladder reduced in size; scales and pectoral rays markedly reduced in number; fins, especially the dorsal, anal, and pectorals, larger; longitudinal streaks of alternating light and dark well developed on back and sides; dark saddle between dorsal origin and occiput not crossing midline of back; mouth larger and less inferior; lips coarsely papillose with some plicae on inner edge. Also differs in minor pigmentary characters.

This species has been unrecognized by those who have studied Roanoke River fishes in the past. Cope (1869, p. 236) records *Hypentelium nigricans* (LeSueur) as "abundant in the Roanoke, James, Kanawha and Holston." Jordan (1890, p. 122) notes them to be "common; specimens dark in color. Lat. 1. 47." Fowler (1913, p. 53) reports *nigricans* from "Roanoke River, Holston River and Sinking Creek, Virginia." This report doubtless included specimens of Cope's still extant in the Academy of Natural Sciences of Philadelphia. We recently examined two specimens bearing the

data A.N.S.P. Nos. 6779-6780, Roanoke River, Virginia, collected by E. D. Cope. One specimen of each species is represented. The *nigricans*, 86 mm. standard length, is typical for that species with 46 lateral line scales and pectoral rays 17-17. The smaller specimen, 55 mm. long, is *roanokense* and has 42 scales. Fowler (1923a, p. 11) also records young of *nigricans* from the Dan River west of Danville, Pittsylvania County, Virginia. Fowler (1923b, p. 12) again reports *nigricans* from the Roanoke River. In his latest work Fowler (1945, p. 74) gives the records noted above but lists them as subspecies, *Hypentelium nigricans nigricans*. He (p. 338) considers *etowanum* as a subspecies and gives some color notes on fresh alcoholic specimens.

In the early stages of this investigation when few specimens of *Hypentelium* were available from the Roanoke, we (Raney and Lachner, 1946a, p. 7) considered the differentiation to be incomplete in *roanokense*. An intensive collecting trip in June, 1946, yielded 92 additional specimens of *roanokense*, some of which were taken with *nigricans*. A study of this large series proves our former concept of intergradation to be without foundation and the two kinds in the Roanoke to be fully differentiated.

Materials were borrowed from the United States National Museum (U.S.N.M.), Washington, D. C., through the courtesy of the Curator of Fishes, Dr. Leonard P. Schultz, and Associate Curator, Dr. Robert R. Miller. Mrs. Marie Poland Fish also assisted by checking certain locality data. Dr. Reeve M. Bailey, Curator of Fishes, Museum of Zoology, University of Michigan (U.M.M.Z.), kindly sent us specimens under his care. Dr. Carl L. Hubbs collected considerable material reported herein

TABLE 1
SCALE AND FIN RAY COUNTS OF *Hypentelium*

Species	roano- kense		nigricans											
River system and states	Roanoke, Va. Holotype	Roanoke, Va. Paratypes	Roanoke, Va.	Atlantic, S. of Roa- noke, N. C., S. C.	Appomattox, Va.	James, Va., W. Va.	Rappahannock, Va.	Potomac and upper Chesapeake, Va., Md.	Susquehanna, N. Y.	Lake Ontario, N. Y.	Ohio (except New and Tenn.), Pa., Ohio, W. Va., Ill., N. Y.	New, Va., W. Va., N. C.	Tennessee, Va., N. C.	TOTAL (<i>nigricans</i>)
Lateral line scales	50		—	—	—	—	—	1	—	—	—	—	2	3
	49		1	—	—	1	—	1	—	2	—	4	3	12
	48		—	—	—	4	—	2	2	—	7	10	12	37
	47		6	3	—	10	3	9	4	3	20	10	19	87
	46		16	2	2	8	1	11	11	15	22	7	10	105
	45		6	2	3	1	7	5	7	4	7	—	8	50
	44	5	5	—	2	2	—	—	1	1	1	—	—	12
	43	15												
	42	24												
	41	31												
	40	22												
	39	4												
	38	1												
Total		102	34	7	7	26	11	29	25	25	57	31	54	306
Mean		41.4	45.8	46.1	45.0	46.6	45.6	46.5	46.0	46.0	46.4	47.4	47.0	46.4
Scales above lateral line	8		2	16	2	1	—	2	1	—	7	9	13	58
	7	1	66	18	—	15	3	14	18	12	53	18	24	175
	6		11	—	—	1	—	—	—	1	4	—	—	6
Total		79												239
Mean		6.9												7.2
Scales below lateral line	7		—	2	—	—	—	—	—	—	—	1	—	3
	6	1	56	24	2	7	—	3	4	2	31	15	18	113
	5		23	8	—	8	3	12	15	11	32	10	12	111
Total		79												227
Mean		5.7												5.5
Pectoral rays (total left plus right)	38		1	—	—	1	—	—	—	—	—	—	1	3
	37		4	—	—	1	—	—	—	—	1	1	2	9
	36		12	1	1	8	1	—	—	2	7	7	14	53
	35		4	2	1	6	—	1	—	1	10	5	5	35
	34		8	4	3	9	4	4	2	10	27	13	8	92
	33		4	—	—	2	—	2	9	3	8	3	1	32
	32		36	1	—	2	—	2	10	7	3	2	—	28
	31		18	—	—	—	—	1	4	1	1	—	—	6
	30		40	—	—	—	1	—	—	—	—	—	—	1
	29		4	—	—	—	—	—	—	—	—	—	—	
	28	1	2											
Total		102	34	7	7	27	8	8	25	24	57	31	31	259
Mean		30.9	35.1	34.6	33.9	35.0	33.3	33.6	32.4	33.4	34.2	34.5	35.4	34.3
Dorsal rays ¹	12		6	1	1	—	—	—	—	2	2	1	4	11
	11	1	74	21	5	7	25	10	24	22	48	27	43	255
	10		3	—	—	1	1	1	2	1	6	1	6	19
Total		83												285
Mean		11.0												11.0

¹ For additional counts, see Hubbs (1930, p. 42).

TABLE 2
LATERAL LINE SCALES PLUS PECTORAL RAYS IN *Hypentelium*

Drainage and States	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	Total	Mean
<i>Hypentelium roanokense</i> , Roanoke, Va.	1	3	10	18	26	21	18	6	—	—	—	—	—	—	—	—	—	—	—	103	72.1
<i>Hypentelium nigricans</i> , Roanoke, Va.	—	—	—	—	—	—	—	—	—	1	2	3	6	8	11	2	1	—	—	34	80.9
Atlantic, south of Roanoke, N. C. and S. C.	—	—	—	—	—	—	—	—	—	—	—	2	—	4	—	1	—	—	—	7	80.7
Appomattox, Va.	—	—	—	—	—	—	—	—	—	2	2	—	2	—	1	—	—	—	—	7	78.9
James, Va. and W. Va.	—	—	—	—	—	—	—	—	—	—	1	1	5	7	3	4	3	1	1	26	81.7
Rappahannock, Va.	—	—	—	—	—	—	—	—	1	1	—	4	—	2	—	—	—	—	—	8	78.9
Potomac and upper Chesapeake, Va., Md.	—	—	—	—	—	—	—	—	—	—	1	3	2	2	—	—	—	—	—	8	79.6
Susquehanna, N. Y.	—	—	—	—	—	—	—	—	3	4	6	7	2	3	—	—	—	—	—	25	78.4
Lake Ontario, N. Y.	—	—	—	—	—	—	1	—	—	—	5	6	7	3	—	2	—	—	—	24	79.8
Ohio (except New & Tenn.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N. Y., Pa., Ohio, W. Va., Ill.	—	—	—	—	—	—	—	—	1	—	1	10	16	14	8	3	3	—	—	56	80.6
New, Va., W. Va., N. C.	—	—	—	—	—	—	—	—	—	—	1	—	5	6	9	6	2	2	—	31	81.7
Tennessee, Va., N. C.	—	—	—	—	—	—	—	—	—	—	—	—	1	5	8	6	7	3	1	31	82.9
TOTAL (all <i>nigricans</i>)	—	—	—	—	—	—	1	5	8	19	36	46	54	40	24	16	6	2	—	257	80.8

and gave personal assistance and encouragement on a recent visit to the United States National Museum. Dr. Henry W. Fowler made available Cope's Roanoke specimens and otherwise assisted us when at the Academy of Natural Sciences of Philadelphia, (A.N.S.P.) Pennsylvania. Dr. C.M. Breder, Jr., Curator of Fishes, the American Museum of Natural History (A.M.N.H.) has given valued suggestions. A grant from the Trustee-Faculty Research Committee, Cornell University, Ithaca, New York, defrayed a large part of the cost of the field work. Specimens labeled C.U. are in the Fish Collection of Cornell University.

RANGE AND RELATIONSHIPS

Heretofore but two species of *Hypentelium* have been generally recognized; *nigricans*, a wide-ranging species, is known from southern Minnesota through the en-

tire Mississippi River and Lake Michigan drainages of Wisconsin, the lower peninsula of Michigan, southern Ontario, and New York; south to Georgia on the east side of the Appalachians; to the Tennessee River system of Georgia and Alabama, to the Gulf slope of Mississippi and to southwestern Arkansas and eastern Oklahoma (see Hubbs and Lagler, 1941, p. 42, and Hubbs, 1945, p. 14). According to Hubbs (1930, p. 43) *nigricans* appeared to be fairly consistent in its systematic characters throughout its range. Counts made during the course of this study of specimens in the United States National Museum and Cornell University Fish Collection have shown some slight variation, none of which is considered to be of the level of subspecific differentiation. Some of these minor differences in scale and fin counts are given in tables 1 and 2. Scattered local popula-

tions sometimes show variations in fin length. The pectorals and anal are most variable, a character complicated somewhat since adult males have longer anal fins (see Raney and Lachner, 1946b, p. 77). Some populations, especially those in eastern Maryland, have light and dark streaks better developed along the sides of the body. Other *nigricans* differ in the size and degree of inferiority of the mouth. Some variation in color was noted; there is a tendency for the body to be more coppery in some localities. Interestingly, those *nigricans* found just across the watershed in the mountain headwaters of the James, New, and Tennessee river systems in Virginia and North Carolina have more scales and pectoral rays, an opposite trend from *roanokense*. Further studies are needed on the geographical variation of *nigricans*, particularly those from the Atlantic waters of North Carolina, South Carolina, and Georgia.

Hypentelium etowanum (Jordan), described and known only from the Alabama River system, was considered a subspecies by Jordan (1877, p. 346; 1878, pp. 159, 162) and Fowler (1945, pp. 24, 338). Hubbs (1930, p. 43) regarded *etowanum* as a full species since no evidence of intergradation was found. It is separated on the basis of 10 dorsal rays (rather than 11), red lower fins, and differences in general physiognomy. No new information is available on this species. The few specimens of *Hypentelium* which we have seen from streams south of the Roanoke River system, other than the Alabama system, have been typical *nigricans*.

The new species, *roanokense*, is limited to the headwater streams of the Roanoke River system. *H. nigricans* also occurs in the Roanoke but generally is found in the larger streams. However, both species were taken together at five localities; *roanokense* alone was collected at 13 places, and *nigricans* was obtained at six other localities. When taken together or alone each species could be separated by a glance, and no hybrids were noted. Only 34 specimens of *nigricans* are available compared with 103 of *roanokense*. Neither species appears to be as common as does *nigricans*

in more northern and western drainages. In 15 collections *roanokense* was taken in small creeks and in three cases in the headwaters of rivers, the Roanoke and North Mayo. During the greater part of the summer these rivers are relatively small streams. On the other hand *nigricans* was secured in rivers in six cases and in small streams five times. In all collections except one where the two species occurred together, *roanokense* was more common; in this single case one specimen of each was collected. Detailed distribution as represented by available specimens of *roanokense* and *nigricans* within the Roanoke River system is shown on the map (fig. 2). A detailed study of the ecology and breeding behavior of these species where they occur together would be most illuminating.

A study of the available specimens indicates a close relationship between *nigricans* and *etowanum*. On the other hand *roanokense* has probably evolved from *nigricans* stock but is fully differentiated and may be easily separated. Many of the differences are given in table 3. A few others were observed in a comparison of the two species when taken together. For example *roanokense* has a broader head and snout; more dark pigment in the anal fin; generally darker ground color on body; longer pectoral fins; and in adults, the anal fin reaches far beyond the end of the hypural while it barely reaches the hypural in *nigricans*.

KEY TO THE SPECIES OF *Hypentelium*

- 1A. Dorsal fin rays 10. More highly colored in life; lower fins red, basal part of dorsal fin orange, snout reddish, lips orange. Range: Alabama River system. Alabama hog sucker, *Hypentelium etowanum* (Jordan)
- 1B. Dorsal fin rays 11. Colors generally dull; lower fins light orange or brown, snout and lips dusky or light but not orange. 2A
- 2A. Posterior fontanelle reduced to a slit. Air-bladder reduced in length and thin. Lateral line scales 41. Pectoral fin rays 31. Lateral line scales plus pectoral fin rays 72.

TABLE 3

COMPARISON OF SOME CHARACTERS OF *Hypentelium roanokense* AND *Hypentelium nigricans*
(*Hypentelium etovanum* may be distinguished on basis of 10 dorsal rays, rather than 11, and red lower fins)

SPECIES	<i>roanokense</i>	<i>nigricans</i>
Posterior fontanelle	Reduced to a slit	Large, rectangular
Air-bladder	Reduced in adults; posterior lobe short and thin	Not reduced radically
Size	Dwarf, largest female 125 mm. (4.9 in.) total length; largest male 105 mm. (4.1 in.) (Table 6)	Larger (see Raney and Lachner, 1946, for growth study)
Scales in lateral line	Larger; 38-44 (mean 41.4)	Smaller; 44-50 (mean 46.4)
Pectoral fin rays	Fewer; 28-33 (mean 30.9)	More; 30-38 (mean 34.3)
Lateral line scales plus pectoral rays	Fewer; 68-75 (mean 72.1)	More; 75-86 (mean 80.6)
Dark saddle between origin of dorsal and occiput	Obsolescent, not crossing midline of back	Well developed, although broken into spots in some large adults
Alternating longitudinal light and dark streaks		
1. Along the sides	Prominent	Missing or poorly developed
2. On the back	Developed	Absent
Coloration of snout	Dusky with overlying irregularly shaped dark markings	Dusky, more or less evenly pigmented
Mouth	Larger and less inferior	Smaller and more inferior
Lips	Coarsely papillose on outer edges, subplicate on inner	More finely papillose
Caudal fin	Shorter with shallow fork	Longer and more deeply forked
Anal and dorsal fins	Longer	Shorter
Caudal peduncle depth	Less deep (see table 5)	Deeper
Eye (progressively smaller in relation to head length in large specimens)	Smaller	Larger

Dark saddle before dorsal fin obsolescent, not crossing midline of back. Lips subplicate on inner edge. Light streaks developed along scale rows on back. Dwarf species; largest specimen 6 inches. Range: Upper Roanoke River system, Virginia.....
.....Roanoke hog sucker, *Hypentelium roanokense*, new species

- 2B. Posterior fontanelle large and rectangular. Air-bladder normal. Lateral line scales 46. Pectoral rays 34. Lateral line scales plus pectoral fin rays 81. Dorsal saddle before dorsal fin well developed; crosses midline of back. Lips papillose on inner edge. Lacks light streaks on scale rows on back. Reaches a length of 14.5 inches. Range: Widespread in North America; occurs in the Roanoke River

system but not in the Alabama River system.....
.....Common hog sucker, *Hypentelium nigricans* (LeSueur)

MATERIAL

The holotype (A.M.N.H. No. 17025) is a breeding male 63 mm. standard length collected by Edward C. Raney, Ernest A. Lachner, and Roman A. Pfeiffer on April 3, 1941, in Horse Pasture Creek, at U. S. Highway 58 crossing, 1.5 miles northeast of Spencer, Henry County, Virginia; the paratypes, not differing from the holotype in any essential characters, are listed below. All are from the Roanoke River system, Virginia.

TRIBUTARIES OF DAN RIVER

Henry County: C.U. No. 9580: 1 female 64 mm. long, taken by Raney, Lachner, and Pfeiffer, on April 3, 1941, in Leatherood Creek, 10 miles west southwest of Callands. U.M.M.Z. No. 143184: 4 males and 7 females 49 to 59

mm. standard length, collected by Carl L. Hubbs and E. P. Creaser, on May 17, 1931, in North Mayo River at Virginia Highway 12 (with 5 *nigricans*). C.U. No. 10495: 1 female 117 mm., collected by Raney, Lachner, and R. D. Ross, on June 22, 1946, in Beaver Creek, 1.5 miles northwest of Martinsville.

Patrick County: C.U. No. 9555: 1 female 64 mm., taken by Raney, Lachner, and Pfeiffer, on April 3, 1941, in Anglin Creek, 1 mile west of Patrick Springs. U.S.N.M. No. 104029: 1 male 51 mm., secured by Leonard P. Schultz and Earl D. Reid, on June 13, 1937, in Spoon Creek, 3 miles south of Critz on route 58. C.U. No. 10490: 3 males and 2 females 50 to 75 mm., collected by Raney, Lachner, and Ross, on June 22, 1946, in Spoon Creek, 2 miles south of Critz (with 1 *nigricans*). C.U. No. 10486: 7 males and 6 females 41 to 104 mm., taken by Raney, Lachner, and Ross, on June 22, 1946, in branch of North Mayo River, 1.7 miles south of Stella and 5 miles west of Spencer (with 1 *nigricans*). C.U. No. 10482: 19 males and 20 females 56 to 105 mm., taken by Raney, Lachner and Ross, on June 23, 1946, in Peters Creek, 6.5 miles southwest of Stuart.

ROANOKE RIVER AND TRIBUTARIES

Appomattox County: U.S.N.M. No. 100170: 1 female 48 mm. long, taken by S. Abraham, in Cub Creek (East Branch).

Bedford County: C.U. No. 10485: 1 female 101 mm., collected by Raney, Lachner, and Ross, on June 21, 1946, in Elk Creek, 10 miles west of Lynchburg. C.U. No. 10496: 2 males and 2 females 55 to 79 mm., collected by Raney, Lachner, and Ross, on June 21, 1946, in Goose Creek, 4 miles west of Thaxton.

Campbell County: C.U. No. 10488: 1 male 88 mm., taken by Raney, Lachner, and Ross, on June 20, 1946, in Little Falling River, 4 miles west of Redhouse (with 1 *nigricans*).

Charlotte County: C.U. No. 10483: 2 males 59 to 60 mm., collected by Raney, Lachner, and Ross, on June 20, 1946, in Cub Creek, 3.5 miles west of Madisonville.

Franklin County: C.U. No. 10484: 1 male and 2 females 78 to 102 mm., collected by Raney, Lachner, and Ross, on June 22, 1946, in north branch Chestnut Creek, 5 miles south of Rocky Mount.

Montgomery County: C.U. No. 10492: 4 males and 11 females 44 to 108 mm., seined by Raney, Lachner, and Ross, on June 22, 1946, in Roanoke River, 2 miles north of Allegheny Springs (with 11 *nigricans*).

Pittsylvania County: C.U. No. 8432: 1 female 107 mm. long, collected by Raney and Lachner, on April 7, 1940, in Sycamore Creek, 2.5 miles southwest of Alta Vista.

Roanoke County: U.S.N.M. No. 103980: 2 females 69 and 74 mm. long, taken by Schultz and Reid, on June 18, 1937, in Roanoke River at Bennett's Mills.

Collections of *Hypentelium nigricans* not

taken with *roanokense* in the Roanoke River system, Virginia, and used in the comparisons and data given in tables 1 to 4 and plotted on figure 2 are listed below:

C.U. No. 5969: 1 adult female 180 mm. long, secured by Raney, Lachner, and Pfeiffer, on April 3, 1941, in the headwaters of the Dan River, 2 miles northwest of Vesta, Patrick County. U.M.M.Z. No. 95333: 7 juveniles 51 to 71 mm. long, collected by Hubbs and Creaser, on May 16, 1931, in Tinker Creek, just north of Cloverdale, Botetourt County. C.U. No. 10494: 3 juveniles 72 to 86 mm., seined by Raney, Lachner, and Ross, on June 21, 1946, in a tributary of Tinker Creek, at Blue Ridge, Botetourt County. U.M.M.Z. No. 95406: 1 yearling 47 mm., collected by Hubbs and Creaser, on May 17, 1931, in Blackwater River, north of Rocky Mount and 1 mile south of Gogginsville, Franklin County. U.M.M.Z. No. 95334: 2 immature males 65 and 68 mm. long, taken by Hubbs and Creaser, on May 16, 1931, in Roanoke River, near Salem, Roanoke County. C.U. No. 8354: 1 immature female 86 mm. long, secured by Crosswell Henderson, in October, 1940, in Roanoke River, near Roanoke, Roanoke County.

DESCRIPTION

Many of the characters of *roanokense* are shown in figure 1. Additional descriptive characters appear in the key and discussion of relationships given above. Data on counts and measurements are recorded in tables 1 to 6. Further descriptive items based on the holotype and 102 paratypes which are similar in character to the holotype follow. Unless specifically noted counts and measurements were made in a manner described by Hubbs and Lagler (1941, pp. 12-20).

The scales are larger than in other *Hypentelium*. Lateral line scales of holotype 42; of paratypes 38 to 44, mean 41.4; scales above lateral line to origin of dorsal 7, in paratypes 6 to 8, mostly 7; scales below lateral line to origin of anal 6, in paratypes 5 and 6, mostly 6, scales around caudal peduncle 16. Dorsal fin rays 11, in paratypes 10 to 12, mostly 11; caudal rays 18 in all; anal rays 7 in all. Pelvic rays 9-9 (left-right) which is the usual number. Some variation occurred among the paratypes as follows: one with 8-8, two with 8-9, four had 9-8, 63 with 9-9, one had 10-9, and one had 10-10. In *nigricans* the pelvises are almost always 9-9 but with

TABLE 4

CORRELATION DIAGRAM OF LATERAL LINE SCALES AND TOTAL NUMBER OF PECTORAL FIN RAYS OF *Hypentelium* FROM THE ROANOKE RIVER SYSTEM, VIRGINIA
(*nigricans* in italics in upper right-hand corner, *roanokense* in lower left-hand corner)

Lateral line scales	TOTALS	3	4	40	18	1	4	8	4	12	4	1	—	34
		3	4	40	18	36	2	—	—	—	—	—	103	—
48	—	—	—	—	—	—	—	—	—	1	—	—	—	1
47	—	—	—	—	—	—	1	3	2	—	—	—	—	6
46	—	—	—	—	—	1	2	3	2	6	2	—	—	16
45	—	—	—	—	—	—	—	1	—	3	2	—	—	6
44	—	—	—	4	1	—	1	1	—	2	—	1	5	5
43	—	—	—	5	5	5	—	—	—	—	—	—	15	—
42	1	—	14	3	7	—	—	—	—	—	—	—	25	—
41	1	2	10	3	14	1	—	—	—	—	—	—	31	—
40	1	2	7	6	6	—	—	—	—	—	—	—	22	—
39	—	—	—	—	3	1	—	—	—	—	—	—	4	—
38	—	—	—	—	1	—	—	—	—	—	—	—	1	—
		28	29	30	31	32	33	34	35	36	37	38	TOTALS	
Pectoral fin rays														

TABLE 5

PROPORTIONAL MEASUREMENTS OF *Hypentelium* FROM THE ROANOKE RIVER SYSTEM, VIRGINIA
(Mean and range values are given)

Species	<i>Hypentelium roanokense</i>		<i>Hypentelium nigricans</i>
Specimens	Holotype	20 Paratypes	17 Specimens
Standard length in mm.	63	48-107	47-197
In standard length			
Predorsal length	2.1	2.1 (2.0-2.2)	2.1 (2.0-2.1)
Dorsal origin to occiput	4.1	4.1 (3.7-4.4)	4.0 (3.5-4.3)
Body depth	4.7	4.9 (4.1-5.4)	5.0 (4.6-5.4)
Body width	5.3	5.6 (4.1-6.5)	5.7 (5.0-6.1)
Caudal peduncle length	6.0	6.2 (5.5-7.1)	6.0 (5.6-6.5)
Anal fin length ¹	3.8	4.3 (3.7-5.2)	5.2 (4.3-6.1)
Dorsal fin length	3.4	3.5 (3.3-4.1)	3.9 (3.6-4.8)
Head	3.7	3.7 (3.4-3.9)	3.6 (3.4-3.9)
In head			
Snout length	2.0	2.0 (1.9-2.3)	2.0 (1.8-2.2)
Bony interorbital	3.1	3.1 (2.8-3.5)	3.1 (2.6-3.4)
Pectoral fin length	1.1	1.2 (1.0-1.3)	1.2 (1.1-1.4)
Pelvic fin length	1.3	1.5 (1.3-1.7)	1.6 (1.4-1.9)
Dorsal fin origin to lateral line	2.1	2.1 (1.9-2.5)	2.2 (2.0-2.5)
Pelvic fin origin to lateral line	2.7	2.7 (2.0-3.2)	3.1 (2.9-3.7)
Caudal peduncle depth	3.6	3.4 (3.0-4.0)	3.1 (2.9-3.5)
Head depth at occiput	1.6	1.6 (1.4-1.7)	1.6 (1.5-1.7)
In snout			
Eye	2.1	2.2 (1.9-2.9)	2.3 (1.9-3.9)
In distance from pectoral fin origin to pelvic fin origin			
Pectoral fin length	1.1	1.1 (1.0-1.3)	1.2 (1.0-1.5)
In distance from occiput to origin of dorsal fin			
Dorsal fin length	0.9	0.9 (0.8-1.1)	1.0 (0.9-1.1)

¹ Length of all fins measured from the origin to the posterior tip of the longest or last ray, whichever distance was greater.

about the same degree of variation as noted above for *roanokense*. The pectoral fin rays are reduced in *roanokense*, the holotype having 14-14 (28); the paratypes vary from 14-14 to 16-17 with a mean total value of 30.9 pectoral rays. Table 4 is a correlation diagram showing the relationship between the reduction in lateral line scales and number of pectoral rays in *roanokense* and *nigricans* from the Roanoke system.

Various proportional measurements of the holotypes and paratypes are given in table 5. The body is heavy and foreshortened forward, giving it a stockier and more terete appearance than *nigricans*. The ventral contour is horizontal except at the base of the anal fin where it slopes abruptly upward but levels out again along the caudal peduncle and parallels the dorsal surface. At the snout the dorsal contour is rather less abrupt than in *nigricans*, rises evenly from the concave region between the eyes to a point at or before the dorsal, hence decreases abruptly and again levels off near the posterior base of the anal fin. The dorsal fin is large, its posterior margin reaching a vertical from the origin of the anal fin in the holotype. All the lower fins are also large; the pectoral almost reaches the pelvic origin in the holotype and exceeds this point in many paratypes. The pelvic fin reaches the base of the anal papilla. The anal fin is very large and reaches the last small scales extending out on the base of the caudal fin. The size is small; the largest specimen is a female 117 mm. in standard length.

Among the modifications for life in small swift streams other than the short heavy body is the reduction in the size of the air-bladder in adults. It is in two parts; the posterior half is small and thin, occupying a position far forward in the body cavity. Compared with small specimens (50 mm. standard length) of *nigricans* the posterior lobe of the bladder is only slightly shorter but is much thinner. In large adults of *roanokense* the difference in comparative length of the air-bladder is notable. The posterior fontanelle is reduced to a slit which usually may be seen through the skin of the head just anterior to the nape. In

nigricans the posterior fontanelle is relatively large and rectangular. The parallel development undergone by *roanokense* and the two species of *Thoburnia*, other suckers found in a similar habitat in mountain streams of Virginia, in regard to the above two characters is most striking. Characters of *Thoburnia* have been studied by Hubbs (1930, p. 44) and Raney and Lachner (1946c).

The mouth is relatively large and less inferior than in *nigricans*. The lips, especially the upper, are modified in adults. They are coarsely papillose on the outer border, but plicate on the inner edge. This is one of the strongest differences noted, since the lips in *nigricans* have smaller papillae and show no tendency toward plicae formation.

The body is rather sharply bicolored with the dark background of the back extending about one and one-half scale rows below the lateral line. Each scale has a narrow longitudinal light area through the middle. These line up to produce a pronounced longitudinal streaking of alternating light and dark. It is observable on the back in front and behind the dorsal. Some populations of *nigricans* have these light streaks along the sides, and, according to Jordan (1877, p. 346), they are also an outstanding feature of *etowanum*. In neither of these species are the light streaks developed on the back.

Four dark saddles cross the back. The first and broadest is at about the middle of the dorsal fin, the next is just posterior to the dorsal fin base, the third is a little anterior of a point midway between the dorsal base and the base of the caudal, and the last is a narrow one just anterior of the caudal base. No saddle crosses the back between the occiput and the dorsal fin origin, a character which *nigricans* possesses. The remains of this saddle are present along the side. After crossing the back the saddles are inclined forward and finally are expanded laterally into a broad dark band broken by small light areas. The occiput is outlined in black.

The background color of the head is dusky with additional dark irregular blotches. They cover the snout and side of

head just below the eye. The opercle, above and in front, is dark with overlying darker blotches. The dorsal aspect of the pectoral and pelvic fins is irregularly and rather sparsely speckled with dark. The middle rays of the anal fin are dark. The dark in the middle of the dorsal fin mostly coincides with the location of the dark saddle on the back. The dorsal fin rays are also dusky near the edge in some. The scales on the posterior caudal peduncle overlying the hypural plate are dusky, but the last row of small scales at the base of the fin is light. The caudal fin membranes are dusky near the base. This dark tends to run out to the edge of the fin in the more dorsal and ventral rays and meets a faint darkish band edging the fin. The area in the middle of the fin is relatively light. The life colors of an adult paratype collected in Spoon Creek, 2 miles south of Critz, Patrick County, on June 22, 1946, are as follows. Dorsal half of body and head brown crossed by black saddles. Lower sides and belly white. Pectoral, ventral, and anal fins light orange. Caudal fin with light copper near base. Dorsal with dusky streak. Iris brown. In Peters Creek, 6.5 miles southwest of Stuart, Patrick County, 39 paratypes were taken in red silt-laden water. These specimens were copper colored dorsally where *roanokense* is normally brown or blackish.

There is no sexual dimorphism in coloration, but some other differences are noted. Adult males, although smaller than females, have all fins longer. The difference in size of the anal fin is most notable, and two individuals of the same size but opposite sexes may be separated at a glance. In mature males the length of the anal fin goes into the standard length from 3.5 to 4.0 (mean 3.6) times rather than 3.7 to 4.1 (mean 4.0) times. The pelvic fin length into standard length is 4.5 to 5.2 (mean 5.0) compared to 5.2 to 5.9 (mean 5.6) in females. The difference in the dorsal, pectorals, and caudal is a little less than that for the other fins. The holotype, a breeding male only 63 mm. in standard length, is covered with pearl organs. They are strongest on the anal and caudal fins where a row of strong conical tubercles lies laterad

of each fin ray; those on the lower half of the caudal are larger than those placed more dorsally. Smaller tubercles line the rays on the upper side and a few are seen underneath the pectoral and pelvic fins, and still smaller ones are present on the dorsal fin. Small pearl organs cover the head and dorsal aspect of the body. Ventrally they become more scarce. The females also have smaller pearl organs on the same parts of the body. They are particularly well developed on the head and anterior body and form a fine shagreen which is rough to the touch.

The scales are similar to, but slightly more elongate than, those of *nigricans* which have been described and figured by Raney and Lachner (1946b, p. 80). The pharyngeal arch is moderately curved with a single row of teeth numbering about 40-40 in one paratype. The base of the arch is about twice as broad as high. The teeth are comb-like, each with a broad base which narrows until gradually at one-third of its length the two edges are parallel. Each tooth widens abruptly near the distal edge. The teeth are about three times as high as wide rather than four to five times in *nigricans*. The edges appear to be slightly more raptorial with a rather sharp point on one border and with a long, relatively sharp grinding surface. They are not molariform, although those near the symphysis of the arches are most sturdy and somewhat rounded.

In an adult paratype the gill rakers are 9 + 10, counting all rudiments. We count a few more in *nigricans*, but no detailed study was made on the variation in this character. The largest developed gill rakers near the center of the arch go about 1.7 times in the longest gill filaments. Each outer gill raker on the first arch is triangular in shape with the outer edge the longest leg. The shorter leg is attached to the gill bar. The inner side has a row of six to eight fleshy papillae and is covered with smaller fleshy tubercles which are larger and more numerous than in *nigricans*.

AGE AND GROWTH

The dwarf character of this species as compared to *nigricans* is demonstrated by a

TABLE 6

LENGTH FREQUENCIES FOR EACH AGE GROUP OF *Hypentelium*
FROM THE ROANOKE RIVER SYSTEM, VIRGINIA
(Included are all *Hypentelium* taken in the Roanoke, numbering
103 *roanokense*, all types, and 34 *nigricans*)

Age in Years	I				II				III		IV		V		VI	VII
Species	<i>roano- kense</i>		<i>nigri- cans</i>		<i>roano- kense</i>		<i>nigri- cans</i>		<i>roano- kense</i>		<i>roano- kense</i>		<i>ro- ano- kense</i>	<i>nig- ri- cans</i>	<i>nigri- cans</i>	
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♀	♀	♂	♀
Total length in mm.	280	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
	240	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
	215	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
	160	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
	155	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
	140	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
	135	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
	130	—	—	—	—	—	1	1	—	—	—	2	—	—	—	—
	125	—	—	—	—	—	—	—	1	—	—	2	1	—	—	—
	120	—	—	—	—	1	—	—	1	—	—	1	1	—	—	—
	115	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—
	110	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—
	105	—	—	1	1	1	—	—	—	—	—	1	—	—	—	—
	100	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—
	95	—	—	1	—	—	3	—	1	—	—	1	1	—	—	—
	90	—	—	1	1	2	3	—	—	—	1	—	—	—	—	—
	85	—	—	1	1	6	7	—	—	—	—	—	—	—	—	—
	80	1	—	3	3	3	6	—	—	—	—	—	—	—	—	—
	75	1	—	—	4	8	4	—	—	—	—	—	—	—	—	—
	70	6	1	1	1	4	—	—	—	—	—	—	—	—	—	—
	65	4	7	1	2	1	—	—	—	—	—	—	—	—	—	—
	60	4	7	1	3	—	—	—	—	—	—	—	—	—	—	—
	55	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	16	17	10	16	25	26	3	2	1	4	3	9	2	1	1	1
Range	63– 81	57– 71	62– 105	60– 105	66– 105	75– 120	132– 160	130– 139	—	110– 125	90– 100	97– 140	124– 127	—	—	—
True Mean	68.1	63.1	82.3	76.0	80.1	88.4	149.0	134.5	95.0	118.8	96.3	120.7	125.5	215	240	280

study of the age, based on an examination of the scales, of available specimens. The data are given in table 6. Total length is used to make the information comparable to growth data for *nigricans* from other localities published elsewhere by Raney and Lachner (1946b, p. 82). Total length may be converted to standard length by multiplying total length by 0.81, and, conversely, standard length converted to total by multiplying by 1.23. Even though only a few specimens of *nigricans* in the higher age groups are available from the Roanoke, the data show the main growth trend to be like that of *nigricans* elsewhere.

On the other hand *roanokense* always grows more slowly and by the end of the second year has fallen far behind. Figure 3 shows this striking difference when the growth rate of *roanokense* is compared with that of *nigricans* from the Genesee River in New York.

Most males mature at two years of age. However, two mature males only one year old and 71 mm. total length, with well-developed nuptial tubercles, were examined in a collection taken in North Mayo River, Henry County, on May 17, 1931. One other male one year of age in the same collection was not sexually mature, as revealed

by an examination of the testes, although some breeding tubercles were present. The scales revealed that coincident with attainment of maturity in its third summer the growth of the male is relatively slow. Until this time males grew slightly faster and reached a larger average size. However, during the third summer of life the females grow faster, overtake the males, then mature and spawn when three years old. In age groups 3, 4, and 5 only four males as compared with 15 females were found. This trend indicates a differential death rate which, although based on few data, is probably significant. It parallels the situation existing in *Thoburnia rhotoea*, as reported by Raney and Lachner (in press).

HABITAT

The type locality, Horse Pasture Creek, 1.5 miles northeast of Spencer, Henry County, Virginia, is a shallow open stream about 15 feet wide with a rather unstable sand bottom which is constantly shifting. Although white in color the water carries a rather heavy load of sand and fine silt

which gives it a slightly turbid appearance. The current was moderate and the flow about 20 cubic feet per second on April 3, 1941. The other species taken here were *Catostomus c. commersonnii*, *Nocomis leptocephalus*, *Notropis caeruleus*, and *Ambloplites rupestris rupestris*.

Most paratypes were taken in small streams, usually under 25 feet in width, although they are not uncommon in the upper reaches of the Roanoke River. In many cases the bottom of the streams was of shifting sand with little or no gravel. In these situations cover was furnished by logs, leaves, and detritus. Peters Creek, 6.5 miles southwest of Stuart, Patrick County, yielded most specimens (39 were obtained in one hour's seining) and easily outnumbered any other species present. This stream is a rather swiftly flowing mountain brook only 10 feet wide with mostly sand bottom but also with considerable loose rubble and gravel in the riffles. It carried a heavy load of red silt and the *roanokense* were quite red, more so than at any other locality.

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Fig 1 *Hypentelium roanokense*, new species. Holotype, an adult male, 63 mm in standard length, collected by Edward C. Raney, Ernest A. Lachner, and Roman A. Pfeiffer on April 3, 1941, in Horse Pasture Creek, at U. S. Highway 58 crossing, 1.5 miles northeast of Spencer, Henry County, Virginia. Photographed by Art Smith.

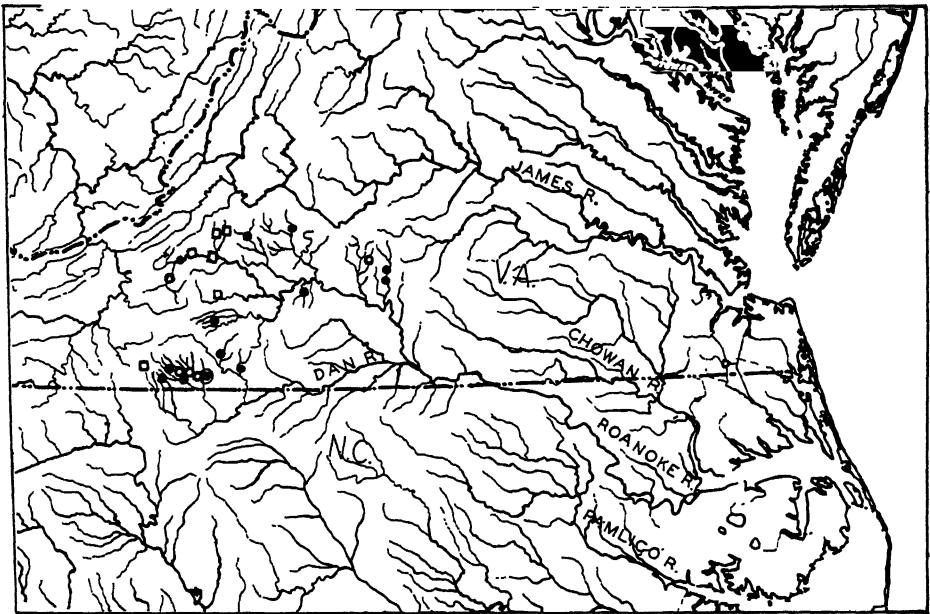


Fig. 2. Record stations for *Hypentelium* in the Roanoke River system, Virginia. A solid circle indicates *roanokense* (the type locality, Horse Pasture Creek, 1.5 miles northeast of Spencer, Henry County, is encircled), a hollow circle records both *roanokense* and *nigricans* taken together, and a hollow square marks localities where *nigricans* alone was collected.

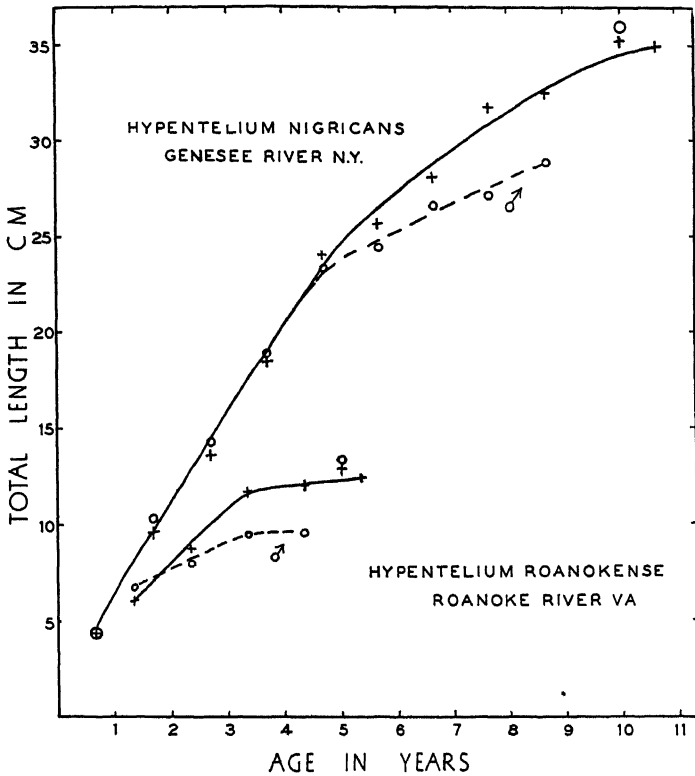


Fig. 3. Growth curves of *Hypentelium* illustrating the dwarf character of *roanokense*. Mean values for each age class are marked with a hollow circle for males and a cross for females. The upper curve of *Hypentelium nigricans* is based on a sample of 181 specimens secured in the Genesee River, 4 miles south of Wellsville, Allegheny County, New York, on August 12-16, 1940 (see Raney and Lachner, 1946b, p. 84). The lower curve of *Hypentelium roanokense* represents 103 specimens, all types, collected in the Roanoke River system, Virginia (see table 6). The available specimens of *Hypentelium nigricans* from the Roanoke fit the upper curve fairly closely.

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NORTH AMERICAN AGELENIDAE OF THE GENUS *WADOTES* CHAMBERLIN¹

BY MARTIN H. MUMA²

This review of North American spiders of the genus *Wadotes* Chamberlin is based on material in the collections of the American Museum of Natural History, New York, New York, the United States National Museum, Washington, D. C., and the Museum of Comparative Zoölogy, Cambridge, Massachusetts. Spiders in the author's private collection were also studied. The types of the single new species described here are deposited in the collection of the American Museum of Natural History.

Acknowledgments are due Dr. W. J. Gertsch of the American Museum, Dr. R. E. Blackwelder of the United States National Museum, and Miss E. B. Bryant of the Museum of Comparative Zoölogy for their cooperation in providing material for this study. The author would also like to express his appreciation to Dr. Gertsch for helpful suggestions during the course of the study, to Miss Bryant for comparing specimens with type material, and to his wife, Katharine E. Muma, for typing and correcting this manuscript.

WADOTES CHAMBERLIN

Wadotes CHAMBERLIN, 1925, Proc. Biol. Soc. Washington, vol. 38, p. 120 (*Wadotes dixiensis* Chamberlin, genotype).

In 1925 R. V. Chamberlin studied the North American spiders previously placed in the genus *Coelotes* Walckenaer and separated them into two genera, *Wadotes* Chamberlin and *Coras* Simon. The genus *Wadotes* was erected for those species having two teeth on the lower margin of the furrow of the chelicerae, the anterior median eyes

much smaller than the anterior laterals, an anteriorly attached median longitudinal tubercle or scape on the epigynum, and two caudally projecting processes at the base of the tarsus of the male palpus. Chamberlin also stated that the legs of these spiders are shorter than in *Coras* Simon which causes the spines to be closer together.

Wadotes is closely related to *Coras*, the spiders of the two genera appearing very much alike in size, shape, and coloration on gross examination. Closer examination reveals several differences which seem to be of generic importance. Among these, in addition to those given by Chamberlin, are the ratio of cephalic to thoracic width and the space occupied by the eye area. In *Coras* the cephalic width is to the thoracic width as 3.5 to 6, while in *Wadotes* the ratio is 4 to 6; in *Coras* the eye area occupies two-thirds of the width of the cephalic part, while in *Wadotes* the eyes occupy one-half of the width.

These moderate to large spiders are quite robust and are provided with strong, moderately long legs.

The cephalothorax is subovate in outline, narrowed on the cephalic part, arched highest in the head region in profile and provided with a distinct median longitudinal furrow, faint radial furrows, and distinct cephalic grooves. In color the cephalothorax varies from a light yellow to a dark yellowish brown, darker on the cephalic part and marked with light to dark gray, dusky bands and stripes as follows: two irregular, dusky stripes arise at the posterior median eyes and converge at the median furrow, three pairs of triangular dusky spots form two curved submarginal stripes, and the cephalothorax is seamed with a fine dusky stripe. There is a sparse

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clothing of dark hairs on the cephalothorax that is most prominent on the eye area and down the middle of the dorsum. Clypeal width is about one diameter of the anterior lateral eyes.

The robust brown to reddish brown chelicerae are provided with distinct light yellow, lateral condyles. The lower margin of the furrow of the chelicerae is provided with two strong teeth, while the upper margin usually carries three teeth, the middle one considerably larger than the other two. Sternum, labium, endites, and legs are moderately clothed with strong black hairs and are brown to yellowish brown. The legs are usually slightly paler with faint dusky bars on the ventral surfaces of the femora and dusky bands on tibiae and metatarsi. The sternum is darker on the margins. Labium is longer than wide and about two-thirds the length of the curved, converging endites. Sternum is subcordate in outline. Legs are provided with strong black spines on the dorsal surfaces of the femora and patellae and both dorsal and ventral surfaces of the tibiae and metatarsi.

The abdomen is ovate in outline, widest at or just behind the middle. It is clothed with a mixture of fine light and dark hairs. The base color is white to light yellow with light to dark gray markings as follows: dorsum dark gray with a light, median, basal, lanceolate stripe extending posteriorly for one-third to one-half the length of the abdomen, and several light chevrons or pairs of diverging light, triangular spots on the posterior half, sides marked with several longitudinal, interrupted, dusky stripes that unite just above the spinnerets. Spinnerets light yellow. Posterior spinneret longest and two-jointed with the basal joint longer than the apical joint.

The epigyna of these spiders are characterized externally by the presence of a fleshy, median, longitudinal scape or tubercle that is attached at the anterior end and free at the posterior end, and a transverse fleshy fold covering the openings to the spermathecae. Specific separation of females depends largely on the shape and length of the scape, position of the spermathecal fold, and internal form and arrange-

ment of the spermathecae and connecting canals.

Separation of males also depends to a large extent on differences in the external reproductive organs. The patella of the palpus bears a small, finger-like process on the ectal surface near the distal end. There is a longitudinal concavity on the ectal surface of the tibia at the ventrodistal corner. The tarsus is cup-shaped and elongate and has a longitudinal concavity on the ectal side at the base. On the mesal side at the base, the tarsus is drawn out into two processes, the length and shape of which may be used for specific separation. Two species do not have the tarsal processes as described. *Wadotes tennesseensis* Gertsch has no distinct tarsal process, while *W. calcaratus* (Keyserling) has the dorsal process nearer the ectal edge of the tarsus. The palpal organ itself is rather simple, consisting of a long tubular embolus that arises near the ectobasal corner of the ventral surface of the tarsus, loops along the mesal edge to the base of the crescent-shaped embolic conductor. The median apophysis is small and shaped somewhat like one shell of a bivalve. The terminal apophysis is large, accompanies the embolic conductor, and apparently acts as an embolic guide. In all species except the divergent forms *tennesseensis* Gertsch and *calcaratus* (Keyserling), the terminal apophysis has a trifurcate, variously developed tip. In the two divergent species the tip of the apophysis is subspatulate. The form of the terminal apophysis is of specific importance.

On the following pages six previously known species and one new species of *Wadotes* are described. The divergent species *tennesseensis* Gertsch and *calcaratus* (Keyserling) are described first so that the genotype, *Wadotes diriensis* Chamberlin, and the four related species may be described and discussed in a group.

Wadotes calcaratus (Keyserling)

Figures 3, 4, 16, 17, 33, 34

Coelotes calcaratus KEYSERLING, 1887, Verhandl. Zool.-Bot. Gesellsch. Wien, vol. 37, p. 470, pl. 6, fig. 32.

Coelotes longitarsus EMERTON, 1889, Trans. Connecticut Acad. Sci., vol. 8, p. 28, pl. 7, fig.

2 (male, not female); BANKS, 1892, Proc. Acad. Nat. Sci. Philadelphia, vol. 44, p. 24, pl. 4, fig. 73.

Coelotes nigriceps BANKS, 1895, Jour. New York Ent. Soc., vol. 3, p. 82.

Wadotes calcaratus CHAMBERLIN, 1925, Proc. Biol. Soc. Washington, vol. 38, p. 121.

MALES: Total length 5.93 to 8.73 mm. Carapace 2.13 to 3.00 mm. wide and 2.73 to 4.73 mm. long. Abdomen 2.06 to 2.60 mm. wide and 3.26 to 4.06 mm. long. Fourth leg 10.06 to 12.73 mm. long.

Spiders small to moderate in size for the genus. Coloration typical except that dusky bands and bars on legs are sometimes missing, and the venter of the abdomen is nearly immaculate in some specimens. Structure typical.

Dorsal process at the base of the tarsus of palpus making up one-fifth to one-sixth of the total length of the tarsus. The longitudinal concavity of the tarsus occupies about one-fourth of the total length of the tarsus and has a deep, narrow, smoothly rounded notch on the basal margin. In ectal view the patellar process is subspatulate, curved gently downward, and more than one-half as long as the segment. The process is club-shaped in dorsal view. The palpal organ is typical of the genus except that the terminal apophysis is subspatulate at the tip with the margins curled so that the structure is trough-like.

The dorsal process of the palpus is somewhat variable. In some specimens it is spatulate, in other specimens truncate; in some it is lightly curved, in others straight.

FEMALES: Total length 5.93 to 10.20 mm. Carapace 2.06 to 3.00 mm. wide and 2.93 to 4.73 mm. long. Abdomen 1.93 to 3.73 mm. wide and 3.06 to 5.60 mm. long. Fourth leg 8.20 to 11.80 mm. long.

Females larger and more robust than males. Legs shorter and stouter. Coloration typical for genus with dusky markings more distinct than in males. Dusky bands and bars on legs faint, indistinct, and often missing.

Epigynum wider than long by a ratio of 2 to 1.5. The scape of the epigynum is long and linear with a truncate tip. It extends about four-fifths of the length of the epigynum, the tip lying over or nearly over the spermathecal fold. The posterior

corners of the epigynum behind the spermathecal fold are sclerotized for a short distance in from the margins. Internally, the small obcordate spermathecae are widely spaced and connected to the spermathecal openings by narrow connecting canals that are twisted in three or four loose loops.

The scape of the epigynum is somewhat variable. In some specimens the margins of the scape are parallel and straight, while in other specimens they are sinuate; in some specimens the tip of the scape is abruptly truncate, while in others the margins taper slightly before the truncation.

TYPE LOCALITY: Keyserling states that Marx found examples in Washington, D. C.; Valmont, Colorado; Bridger, Wyoming; and Minnesota.

RECORDS: *Vermont:* Stowe, September 13, 1934, one female. *New Hampshire:* Randolph, September 10 to 14, 1939, one male and one female, E. L. Bell; September 17, 1940, one male and one female, E. L. Bell. *Connecticut:* Norwalk, June 5, 1933, one female, W. J. Gertsch; June 23, 1933, one female, W. J. Gertsch; July 4, 1935, one female, W. J. Gertsch. *Farmington,* February 16, 1937, one male and one female, B. J. Kaston. *Massachusetts:* Greylock Range, three females, R. W. Miner. *Woods Hole,* January 23, 1902, one female, H. W. Britcher. *New York:* Jamesville, October, 1901, one female, H. W. Britcher. *Saugerties,* August, 1911, one female. *Lake Sebago,* October 8, 1933, several males and females, W. J. Gertsch; May 20, 1934, one female, W. J. Gertsch. *Westchester County,* April 12, 1942, two females. *Lake Kanawauke,* Interstate Park, October 12, 1944, one male, C. J. and M. L. Goodnight. *Michigan:* Warren's Woods, May 26, 1934, one male, E. V. Roovart. *Ann Arbor,* April 4, 1930, one female, E. L. Miner. *New Jersey:* Macopin, November 10, 1913, one male and two females. *Ramsey,* December 1, 1932, three males and one female, W. J. Gertsch; October 8, 1933, one male and two females, W. J. Gertsch; September 20, 1934, several males and females, W. J. Gertsch; April 28, 1940, one female, W. J. Gertsch. *Pennsylvania:* Gettysburg, June, 1933, one male and four females, W. J. Gertsch. *Ohio:* Athens County, Lodi Township, October 11, 1938, one male, W. C. Stohn. *Indiana:* One male and three females, G. Marx. *Turkey Run State Park,* June 30, 1943, one female, C. J. and M. L. Goodnight. *Maryland:* Cumberland, November 20, 1941, five females, M. H. Muma; May 13, 1942, two females, M. H. Muma; December 24, 1942, one male, M. H. Muma; September 16, 1943, two females, M. H. Muma. *Rocky Gap, Allegany County,* November 21, 1941, one female, M. H. Muma. *Rush,*

September 14, 1943, one female, M. H. Muma. Dans Rock, Allegany County, September 15, 1943, one female, M. H. Muma. Boiling Springs, Garrett County, May 5, 1944, one male and one female, M. H. Muma. *Virginia*: Pond Mountain, April 14, 1935, one male, H. A. Allard. Hillsboro, November 8, 1936, one female, J. P. E. Morrison. Warren County, April 14, 1940, one male, J. P. E. Morrison. Mary's Rock, Shenandoah National Park, October 5, 1943, one female, B. Malkin. *North Carolina*: Chapel Hill, one female. Black Mountains, one female and several young, Beutenmuller. Clay County, April 29, 1938, two males, T. H. Hubbell. *Alabama*: Monte Sano, Madison County, December, 1940, one female, A. F. Archer. *Oklahoma*: Stillwater, one male, R. W. Marx. *Arizona*: Santa Catalina Mountains, one female.

This is perhaps the most common species of *Wadotes*. It diverges widely from the more typical species in the great length of the dorsal tarsal process of the palpus. The details of the epigynum and terminal apophysis of the palpus make it closely related to *tennesseensis* Gertsch, the other divergent species of the genus.

Some variation in the scape of the epigynum and the dorsal tarsal process of the palpus was noted, but no consistent correlation could be made that would justify the erection of a new species.

Wadotes tennesseensis Gertsch

Figures 1, 2, 14, 15, 31, 32

Coelotes hybridus BISHOP AND CROSBY, 1926, Jour. Elisha Mitchell Sci. Soc., vol. 41, p. 199 (in part), pl. 25, fig. 49.

Wadotes tennesseensis GERTSCH, 1936, Amer. Mus. Novitates, no. 852, p. 14, fig. 27; KASTON, 1945, Amer. Mus. Novitates, no. 1292, p. 1, fig. 21.

MALES: Total length 5.86 to 6.80 mm. Carapace 2.40 to 2.53 mm. wide and 3.26 to 3.66 mm. long. Abdomen 1.93 to 2.20 mm. wide and 2.66 to 3.20 mm. long. Fourth leg 10.93 to 12.33 mm. long.

This is the smallest species of the genus. Coloration is typical with the markings on cephalothorax, abdomen, and legs being unusually distinct. In proportion to their size these spiders have longer legs than any other member of the genus. Structure typical.

There are no distinct basal processes on the tarsus of the palpus. The longitudinal concavity of the tarsus occupies about one-half of the total length of the tarsus and is

strongly undulate at its base. In ectal view the patellar process is a short, stout, bluntly rounded structure about one-third as long as the segment. It has the same appearance from a dorsal view. The palpal organ is typical of the genus except that the terminal apophysis is truncate at the tip with the distal margin turned downward to form a roof-like trough.

FEMALES: Total length 5.80 to 7.00 mm. Carapace 2.06 to 2.60 mm. wide and 3.06 to 3.86 mm. long. Abdomen 1.93 to 2.33 mm. wide and 2.80 to 3.30 mm. long. Fourth leg 8.20 to 10.73 mm. long.

Females and males nearly the same size, the females being more robust and with shorter, stouter legs. Coloration and structure typical. Markings unusually dark and distinct.

Epigynum wider than long by a ratio of 1.5 to 1. Scape of epigynum long, subspatulate, and narrower at the base than at the tip. It extends two-thirds the length of the epigynum, the tip lying over or nearly over the spermathecal fold. The posterior third of the epigynum, behind the spermathecal fold, is sclerotized except for a central strip the width of the scape. Internally, the small, roughly rectangular spermathecae are situated close together near the middle of the posterior margin and are connected to the spermathecal openings by narrow connecting canals that are twisted sharply in two places.

TYPE LOCALITY: Male holotype, female allotype, and paratypes of both sexes from Mount Leconte, Great Smoky Mountains, Tennessee, in the American Museum of Natural History.

RECORDS: *Tennessee*: Blount, September, 1931, three females, W. M. Barrows. Clingmans Dome, Great Smoky Mountains National Park, June 22, 1941, two females, C. J. and M. L. Goodnight.

At the present time this species is known only from Tennessee and North Carolina. The latter record must remain indefinite until the mixed material, *tennesseensis* Gertsch, *hybridus* (Emerton), and possibly a third species designated as *hybridus* (Emerton) by Bishop and Crosby in 1925, has been studied. The fact that Bishop and Crosby had more than one species

under consideration in their description was first noted by Kaston in 1945.

Although this species lacks the tarsal processes typical of the genus, it is closely related to *calcaratus* (Keyserling) in the form of the epigynum and in shape of the terminal apophysis of the palpus.

Wadotes dixiensis Chamberlin

Figures 22, 23, 28, 29, 30, 37, 38

Wadotes dixiensis CHAMBERLIN, 1925, Proc. Biol. Soc. Washington, vol. 38, p. 120.

MALES: Total length 10.60 to 11.20 mm. Carapace 3.20 to 3.80 mm. wide and 5.66 to 5.80 mm. long. Abdomen 3.20 to 3.46 mm. wide and 5.00 and 5.46 mm. long. Fourth leg 17.20 to 18.80 mm. long.

This is one of the largest species of the genus. Coloration of cephalothorax and legs typical. The abdomens of all specimens studied were bleached or discolored by age. Structure typical.

Tarsal processes of palpus very short, equal or nearly equal in length and separated by a flattened notch that is wider than the length of either process. In mesal view the ventral process is triangular in outline, the dorsal one subspatulate. The ventral process is completely hidden by the broad triangular outline of the dorsal process when the tarsus is viewed from above. The longitudinal tarsal concavity occupies about one-third of the length of the tarsus and has a broad, flattened, rectangular-shaped notch at the base. In ectal view the patellar process is long, about one-half as long as the segment, straight and tapering at the tip; in dorsal view it is club-shaped. The palpal organ is typical. The terminal apophysis is trifurcate with the apical apex short and broad, the median apex long and evenly curved, and the basal apex short and fused to the ventral margin of the median apex.

TYPE LOCALITY: Male holotype from Auburn, Alabama, in the Museum of Comparative Zoölogy.

RECORDS: *Alabama:* Desot Park, De Kalb County, October, 1937, four males.

Miss E. B. Bryant of the Museum of Comparative Zoölogy kindly compared the male used for the figures of this species with

Chamberlin's type and found that, except for a slight size discrepancy, they agreed in the important details.

Although the above record increases the range of *dixiensis* Chamberlin, the female of this species is still unknown.

Wadotes bimucronatus (Simon)

Figures 8, 9, 20, 21, 39, 40

Coelotes bimucronatus SIMON, 1898, Ann. Soc. Ent. Belgique, vol. 42, p. 6; SIMON, 1898, Hist. Nat. Aragn., vol. 2, p. 249, fig. 246.

? *Coelotes bimucronatus* BISHOP AND CROSBY, 1926, Jour. Elisha Mitchell Sci. Soc., vol. 41, p. 198, figs. 47 and 48.

Wadotes bimucronatus CHAMBERLIN, 1925, Proc. Biol. Soc. Washington, vol. 38, pp. 120, 121.

MALES: Total length 7.26 to 8.93 mm. Carapace 2.53 to 2.73 mm. wide and 3.93 to 4.20 mm. long. Abdomen 2.13 to 3.33 mm. wide and 3.40 to 4.80 mm. long. Fourth leg 11.06 to 13.20 mm. long.

Small to moderate-sized spiders. Coloration typical of the genus with markings distinct except for the dusky bands and bars on the legs. Structure typical.

Tarsal processes short, not so short as in *dixiensis* Chamberlin, equal or nearly equal in length and separated by an evenly curved tapering notch. In mesal view both processes are subspatulate. When viewed from above the spatulate outline of the dorsal process hides the tip of the ventral process. The longitudinal concavity of the tarsus occupies about one-third of the total length of the tarsus and is notched at the base as in *dixiensis* Chamberlin. In ectal view the patellar process is long, but less than half as long as the segment, curved gently downward and tapering at the tip. The palpal organ is typical. The terminal apophysis is trifurcate with the apical and basal apexes each about one-half as long as the median apex, which is narrow, elongate, and curved gently in the apical half of its length.

FEMALES: Total length 6.60 to 11.60 mm. Carapace 2.06 to 3.06 mm. wide and 3.06 to 5.06 mm. long. Abdomen 2.33 to 4.26 mm. wide and 3.60 to 6.60 mm. long. Fourth leg 8.33 to 12.62 mm. long.

Small to large-sized spiders. Coloration

typical with the dusky markings on the legs indistinct. Structure typical.

Epigynum wider than long by a ratio of 2 to 1.5. Scape of the epigynum short, broadly triangular in outline and extending to or not quite to the spermathecal fold which lies in the middle or just behind the middle of the epigynum. The area behind the spermathecal fold is sclerotized except for a narrow strip in the middle about the width or a little less than the width of the scape and two small half-moon areas at the end of the spermathecal fold. Internally the spermathecae are elongate and adjacent, as shown in figure 9, with the connecting canals twisting anteriorly along the undulate outside edges of the spermathecae to the spermathecal openings.

There is some variation in the scape of the epigynum with some specimens having this structure more bluntly rounded than others.

TYPE LOCALITY: Male type from North Carolina, in the Museum of Comparative Zoölogy.

RECORDS: *Alabama:* DeSoto Park, De Kalb County, December, 1937, two males, W. B. Jones. Wolf-Den Cave, Colbert County, September 25, 1940, one male, W. B. Jones and A. F. Archer. Cheaha State Park, October, 1940, one male, W. B. Jones. *Georgia:* Tallulah Falls, two females. Clear Lake, Cartersville, March 2, 1933, two females, W. M. Barrows. *North Carolina:* Clay County, April 29, 1938, one male and three females, T. H. Hubbell. *Tennessee:* Great Smoky Mountains National Park, September 3, 1936, two males and one female, W. M. Barrows.

The males described under this species agree rather closely with Simon's description and figure of the type. There is considerable variation in the size of this species, males varying from the size of Simon's type (6 mm.) to nearly 9 mm. as described above. Bishop and Crosby in 1925 described and figured a large male (11.5 mm.) that they called *Coelotes bimucronatus* (Simon); their figures agree well with the species described here. Their specimen would increase the size range of the males to correspond more closely to the females described above.

Large females of *bimucronatus* (Simon)

apparently have been confused with *hybridus* (Emerton) in the past.

Wadotes carolinus Chamberlin

Figures 5, 6, 18, 19, 35, 36

Wadotes carolinus CHAMBERLIN, 1925, Proc. Biol. Soc. Washington, vol. 38, p. 121.

MALE: Total length 8.40 mm. Carapace 2.86 mm. wide and 4.26 mm. long. Abdomen 3.13 mm. wide and 4.20 mm. long. Fourth leg 12.20 mm. long.

This is a moderately large spider for the genus. Coloration is typical with the dusky bands and bars on the legs being unusually distinct. Structure typical.

Tarsal processes, moderately long, about one-fifth the total length of the tarsus and separated by a deep, almost parallel-sided notch. The longitudinal concavity occupies about one-third the length of the tarsus and has a deep, triangular notch at its base. In mesal view the ventral process is narrow, tapered at the tip and with sinuate margins, while the dorsal process is broader and spatulate. When viewed from above the dorsal process is broadly triangular and hooked ectally, hiding the ectal margin of the ventral process. In ectal view the patellar process is a short, narrow, apically pointed structure. In dorsal view the process is spatulate. The tarsal organ is typical. The terminal apophysis is trifurcate with the apical apex short, spur-like, and situated at the base of the median apex. The median apex is straight, elongate, tapering, and bent at the tip. The basal apex is a broad flattened structure about two-thirds as long as the median apex.

FEMALES: Total length 7.73 to 10.46 mm. Carapace 2.53 to 2.93 mm. wide and 4.40 to 4.53 mm. long. Abdomen 2.26 to 4.00 mm. wide and 3.40 to 6.00 mm. long. Fourth leg 11.13 to 11.80 mm. long.

Females moderate to large in size. Coloration typical with markings usually distinct. Structure typical.

Epigynum wider than long by a ratio of 1.6 to 1. Scape of epigynum broadly triangular in outline and short, extending to or just over the spermathecal fold which lies in the middle or just in front of the middle of the epigynum. The area behind

the spermathecal fold is sclerotized except for a strip down the middle about the width of the scape and two half-moon spots behind the ends of the spermathecal fold. Internally the spermathecae are elongate and adjacent, as shown in figure 6, with the connecting canals twisting anteriorly along the straight, diverging, outside edges of the spermathecae to the spermathecal openings.

There is some variation in the scape of the epigynum; some scapes taper gradually to the tip, as in figure 5, others have their sides parallel for a short distance and taper abruptly to the tip, as in figure 7. An internal examination of the epigynum showed, however, no significant differences.

TYPE LOCALITY: Male holotype from Tryon, North Carolina, in Museum of Comparative Zoölogy.

RECORDS: *Alabama*: Four miles east of Fort Deposit, Lowndes County, July 16, 1940, one male, A. F. Archer. Partlow Hospital Grounds, Alberta City, March 8, 1940, two females, A. F. Archer. Shades Mountain, Jefferson County, March 4, 1940, one female, A. F. Archer. Spring Cave, Colbert County, September 25, 1940, one female, W. B. Jones and A. F. Archer. *North Carolina*: Clay County, April 29, 1938, two females, T. H. Hubbell.

The male specimen described and figured here was compared with Chamberlin's type by Miss E. B. Bryant of the Museum of Comparative Zoölogy and found to agree in the important details.

Unfortunately the females described under this species were collected singly or as a single sex so that pairing them with the proper male was extremely difficult. It was decided to describe them under this species as their size and proportions more nearly match the size of Chamberlin's type (8 mm.) and the male described above than they do the size of *dixiensis* Chamberlin. When more material is available or when males and females of *dixiensis* Chamberlin and *carolinus* Chamberlin have been collected together, the females described here may prove to be a mixed lot. Until such a time, however, the description and figures given here should assist in the separation of these specimens from *hybridus* (Emerton) with which they have been confused in the past.

Wadotes hybridus (Emerton)

Figures 10, 11, 24, 25, 41, 42

Coelotes hybridus EMERTON, 1889, Trans. Connecticut Acad. Sci., vol. 8, p. 29, pl. 7, fig. 4, 4a.

Coelotes atilis BANKS, 1892, Proc. Acad. Nat. Sci. Philadelphia, vol. 44, p. 25, pl. 1, fig. 74, pl. 4, fig. 74a.

? *Coelotes hybridus* BISHOP AND CROSBY, 1926, Jour. Elisha Mitchell Sci. Soc., vol. 41, p. 199 (in part, not figure).

Wadotes hybridus CHAMBERLIN, 1925, Proc. Biol. Soc. Washington, vol. 38, p. 122.

MALES: Total length 8.46 to 10.46 mm. Carapace 3.00 to 3.86 mm. wide and 4.40 to 5.40 mm. long. Abdomen 2.46 to 3.13 mm. wide and 4.13 to 5.20 mm. long. Fourth leg 14.13 to 16.26 mm. long.

Medium to large spiders. Coloration typical; leg markings indistinct. Structure typical of genus.

Tarsal processes short and separated by a deep, broad, U-shaped notch that runs ectally for two-thirds of the width of the tarsus. In mesal view the ventral process is a short, heavy, rectangular-shaped structure, while the dorsal process is a thin, ventrally curved blade. When seen from above the dorsal process is a broad flattened plate that usually hides the ventral process. The longitudinal tarsal concavity occupies more than one-third of the length of the tarsus and has a curved tapering notch at the base. The patellar process is long, narrow, curved dorsally, and about one-half as long as the segment in ectal view. In dorsal view the process is club-shaped. The tarsal organ is typical. Terminal apophysis trifurcate with the apical and basal apexes arising from a broad plate that extends below the elongate, evenly curved median apex for more than one-half of its length.

FEMALES: Total length 10.46 to 12.40 mm. Carapace 3.53 to 3.53 mm. wide and 5.26 to 5.80 mm. long. Abdomen 3.53 to 4.46 mm. wide and 5.33 to 6.66 mm. long. Fourth leg 13.60 to 13.66 mm. long.

Large spiders with legs proportionately shorter than in males. Coloration and structure typical of genus.

Epigynum wider than long by a ratio of 2.5 to 1.5. Scape of the epigynum long and tapering at the tip, usually extending

well beyond the spermathecal fold which lies in the anterior half of the epigynum. The area behind the spermathecal fold is sclerotized except for a thin band just behind the fold and a strip down the middle which is the width of, or narrower than, the scape. Internally the spermathecae are elongate and slightly separated, as shown in figure 11, with the connecting canals twisting anteriorly along the curved outside edges of the spermathecae to the spermathecal openings.

TYPE LOCALITY: Male type from Cha-teaugay Lake, Adirondacks, New York, in Museum of Comparative Zoölogy.

RECORDS: *Vermont:* Green Mountains, August, 1915, one female, Miner. *New Hampshire:* Randolph, September 10, 1939, one male and one female, E. L. Bell; September, 1940, one male, E. L. Bell. *Hanover,* one female, Nathan Banks. *Massachusetts:* Beverley, August 19, 1906, one female, E. B. Bryant. *New York:* Utica, one female, G. Marx. *Adirondacks,* one male, H. Britcher. *East Hill, Onondaga County,* 1900, two males and three females, H. Britcher. *Tully,* September, 1900, one female, H. Britcher. *Onondaga Valley,* October 4, 1900, one female, H. Britcher. *Larchmont,* September 11, 1932, one female, W. J. Gertsch. *West Nyack,* April 7, 1936, one female, Paul Richard. *Michigan:* Ann Arbor, May 18, 1937, one female, D. L. Cantrall. *New Jersey:* Ramsey, June 22, 1934, one female and two young, W. J. Gertsch. *Indiana:* one female, G. Marx. *Pennsylvania:* York, one female, G. Marx. *Johnstown,* September, 6, 1935, two males and two females, H. K. Wallace. *Maryland:* Accident, Garrett County, April 8, 1944, one female, M. H. Muma. *Virginia:* Potomac River at Plimmers Island, September, 1918, one female, I. Fox. *New River* October 29, 1943, one male, M. H. Muma. *North Carolina:* Little Switzerland, August 21, 1930, one male and one female, W. S. Creighton. *Georgia:* Gainesville, October, 1938, one female, B. J. Kaston.

This is essentially a northern species, although the author has seen a female from northern Georgia. It has been confused in the south with *bimucronatus* (Simon), *carolinus* Chamberlin, and *convolutus*, new species. Bishop and Crosby's record of *hybridus* (Emerton) is questionable. That they had mixed material has already been pointed out by Kaston in 1945, and it is possible that their North Carolina specimens represent one or more of the southern species as well as *hybridus* (Emerton).

***Wadotes convolutus*, new species**

Figures 12, 13, 26, 27, 43, 44

MALE ALLOTYPE: Total length 11.06 mm. Carapace 3.80 mm. wide and 5.93 mm. long. Abdomen 3.20 mm. wide and 5.26 mm. long. Fourth leg 14.20 mm. long.

Large spider. Coloration typical; dusky markings on legs indistinct. Structure typical with the legs proportionately short for the genus.

Posterior tarsal process considerably longer than anterior process but only occupying about one-seventh of the length of the tarsus. The two processes are separated by a small, irregularly curved notch. In mesal view the ventral process is a small blunt spur, while the dorsal process is a dorsally projecting U-shaped flange, the concavity of which connects with the curved notch separating the processes and forms a dome in the mesal half of the base of the tarsus. When seen from above, the flange-like dorsal process completely hides the ventral process. The longitudinal concavity of the tarsus occupies about one-half of the length of the tarsus and has a notch at the base similar to that found in *dixiensis* Chamberlin. The patellar process in ectal view is a short, straight, stout spur that tapers at the tip. In dorsal view the process is club-shaped. Palpal organ typical. The terminal apophysis is trifurcate with the median apex elongate and evenly curved. The basal apex is elongate, curved, and about two-thirds as long as the median apex. The apical apex is a broad, flattened spur about one-half as long as the median apex.

FEMALE PARATYPE: Total length 9.33 mm. Carapace 3.06 mm. wide and 4.00 mm. long. Abdomen 3.46 mm. wide and 5.40 mm. long. Fourth leg 12.33 mm. long.

Large spider although smaller than allotype. Coloration typical with dusky markings on legs indistinct. Structure typical of genus.

Epigynum wider than long by a ratio of 2 to 1.8. Scape of the epigynum broadly triangular in outline with the sides slightly curved and the tip extending to the spermathecal fold which lies in the posterior half

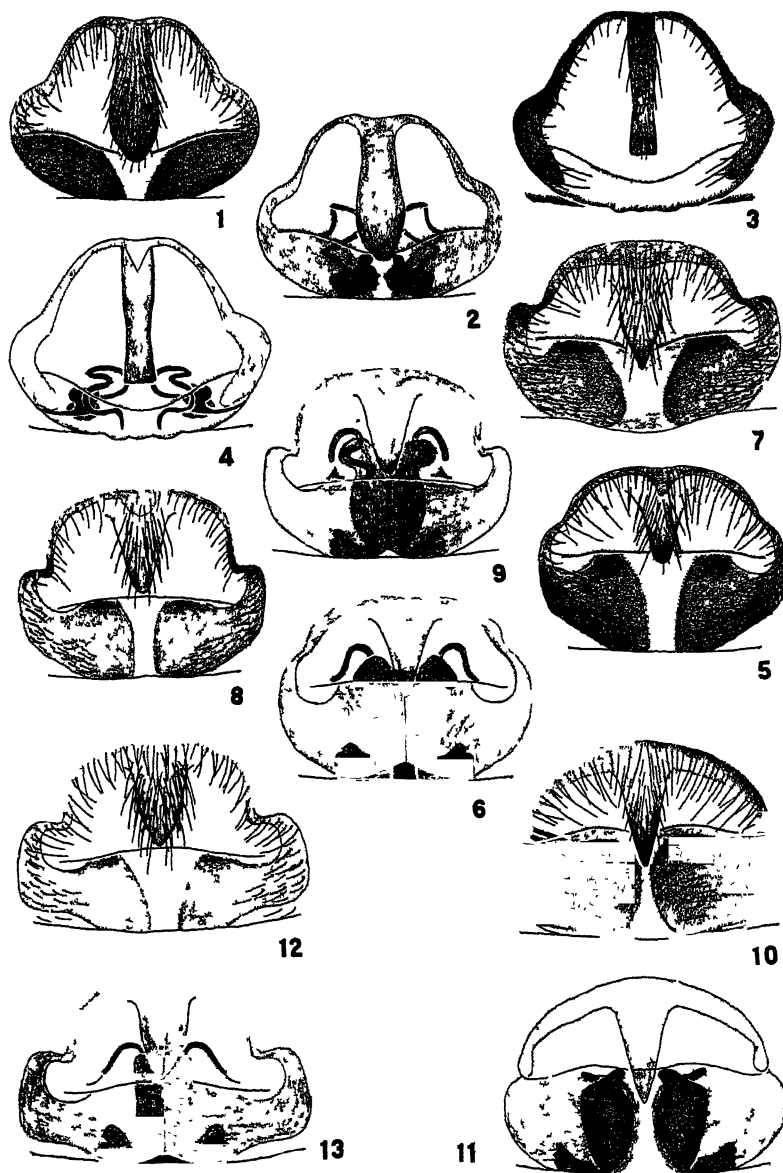
of the epigynum. Area behind the spermathecal fold sclerotized except for a strip slightly wider than the scape down the middle and two half-moon areas at the ends of the fold. In the female holotype the median unsclerotized strip is just the width of the scape. Internally the spermathecae are elongate, rectangular, and adjacent, as shown in figure 13, with the connecting canals twisting anteriorly along the parallel sides of the spermathecae to the spermathecal openings.

FEMALE HOLOTYPE: Total length 9.80 mm. Carapace 2.86 mm. wide and 4.86 mm. long. Abdomen 3.33 mm. wide and

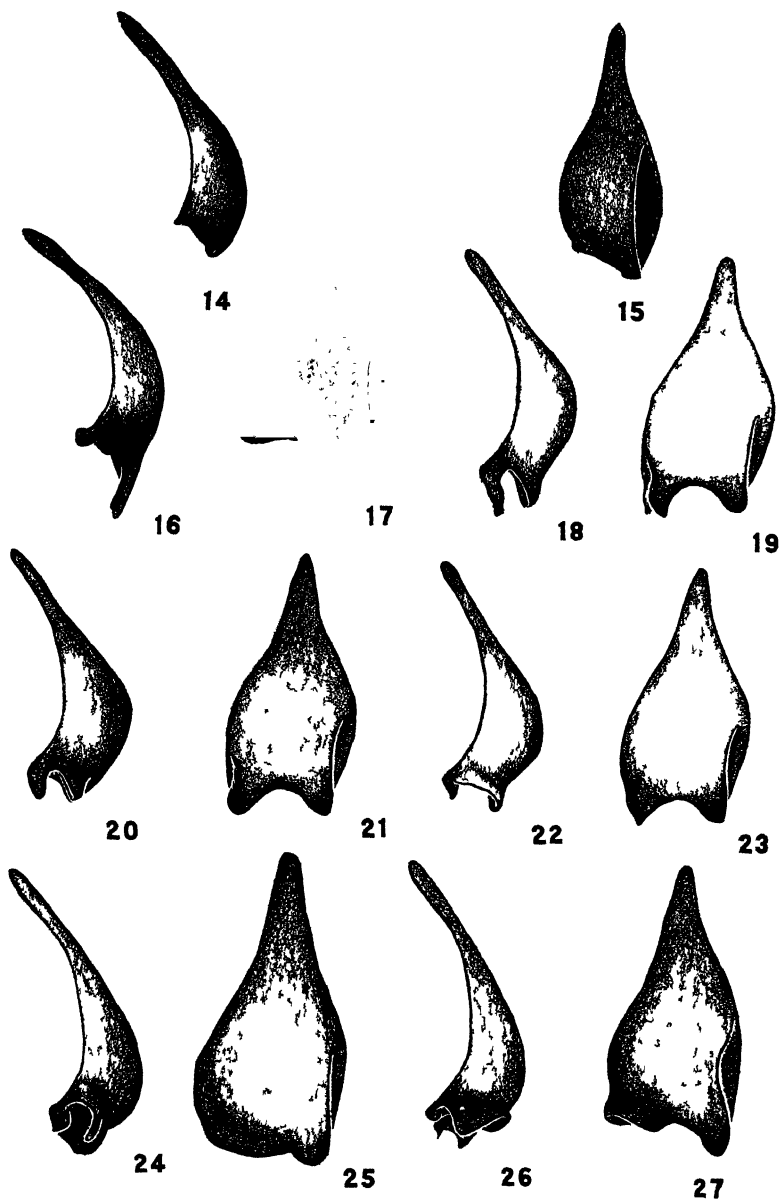
5.13 mm. long. Fourth leg 12.13 mm. long.

TYPE LOCALITY: Male allotype and female paratype from the Blue Ridge Mountains, Georgia. Female holotype from Bishop Cave (Ms5), Bishop Mountain, Marshall County, Alabama, January 12, 1939, A. F. Archer, in the American Museum of Natural History.

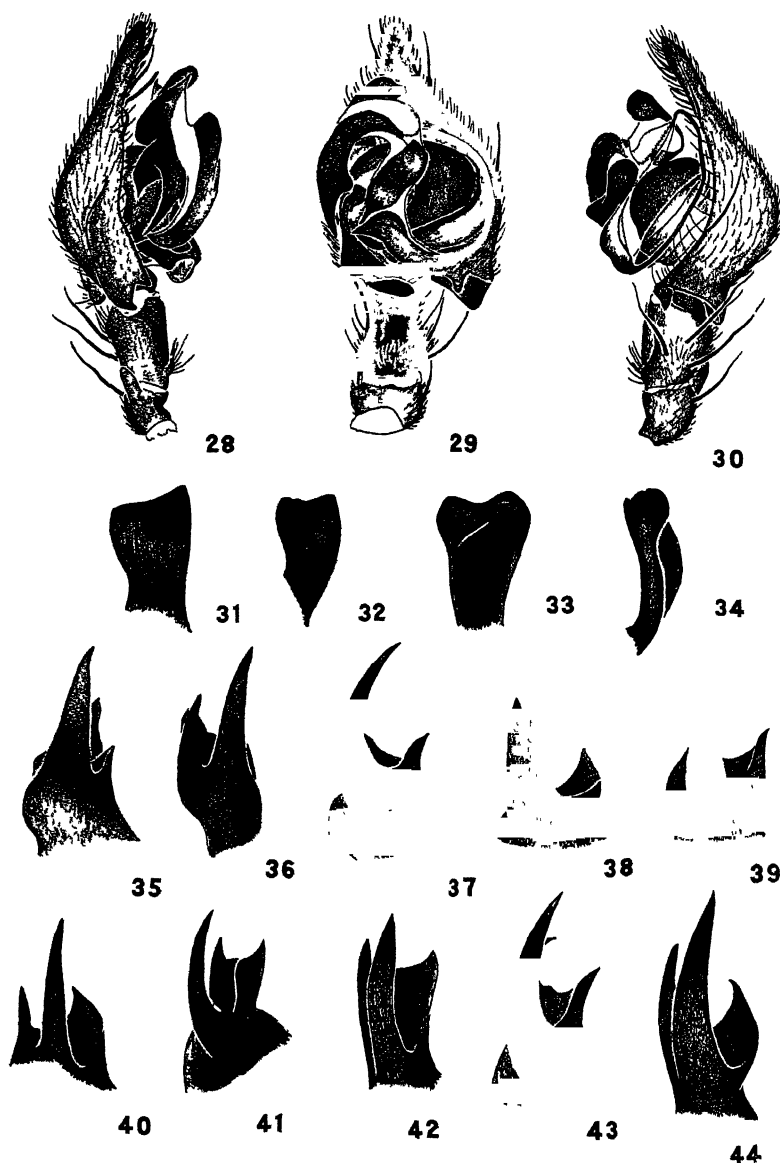
This species has been confused with *hybridus* (Emerton), with which the male closely agrees. The females, however, seem to be more closely related to *bimacronatus* (Simon) and *carolinus* Chamberlin, two species that largely replace *hybridus* (Emerton) in the South.



- Fig. 1. *Wadotes tennesseensis* Gertsch, epigynum, ventral view.
 Fig. 2. Idem, cleared epigynum.
 Fig. 3. *Wadotes calcaratus* (Keyserling), epigynum, ventral view.
 Fig. 4. Idem, cleared epigynum.
 Fig. 5. *Wadotes carolinus* Chamberlin, epigynum, ventral view.
 Fig. 6. Idem, cleared epigynum.
 Fig. 7. Idem, variation of epigynum.
 Fig. 8. *Wadotes bimucronatus* (Simon), epigynum, ventral view.
 Fig. 9. Idem, cleared epigynum.
 Fig. 10. *Wadotes hybridus* (Emerton), epigynum, ventral view.
 Fig. 11. Idem, cleared epigynum.
 Fig. 12. *Wadotes convolutus* new species, epigynum, ventral view.
 Fig. 13. Idem, cleared epigynum.



- Fig. 14 *Wadotes tennesseensis* Gertsch, palpal tarsus, mesal view.
 Fig. 15 Idem, palpal tarsus, dorsal view.
 Fig. 16 *Wadotes calcaratus* (Keyserling), palpal tarsus, mesal view.
 Fig. 17 Idem, palpal tarsus, dorsal view.
 Fig. 18 *Wadotes carolinus* Chamberlin, palpal tarsus, mesal view.
 Fig. 19 Idem, palpal tarsus, dorsal view.
 Fig. 20 *Wadotes bimucronatus* (Simon), palpal tarsus, mesal view.
 Fig. 21 Idem, palpal tarsus, dorsal view.
 Fig. 22 *Wadotes dixiensis* Chamberlin, palpal tarsus, mesal view.
 Fig. 23 Idem, palpal tarsus, dorsal view.
 Fig. 24 *Wadotes hybridus* (Emerton), palpal tarsus, mesal view.
 Fig. 25 Idem, palpal tarsus, dorsal view.



- Fig. 28. *Wadotes dixiensis* Chamberlin, palp, ectal view.
 Fig. 29. Idem, palp, ventral view.
 Fig. 30. Idem, palp, mesal view.
 Fig. 31. *Wadotes tennesseensis* Gertsch, terminal apophysis of palp, ectal view.
 Fig. 32. Idem, terminal apophysis of palp, dorsal view.
 Fig. 33. *Wadotes calcaratus* (Keyserling), terminal apophysis of palp, ectal view.
 Fig. 34. Idem, terminal apophysis of palp, dorsal view.
 Fig. 35. *Wadotes carolinus* Chamberlin, terminal apophysis of palp, ectal view.
 Fig. 36. Idem, terminal apophysis of palp, dorsal view.
 Fig. 37. *Wadotes dixiensis* Chamberlin, terminal apophysis of palp, ectal view.
 Fig. 38. Idem, terminal apophysis of palp, dorsal view.
 Fig. 39. *Wadotes bimucronatus* (Simon), terminal apophysis of palp, ectal view.
 Fig. 40. Idem, terminal apophysis of palp, dorsal view.
 Fig. 41. *Wadotes hybridus* (Emerton), terminal apophysis of palp, ectal view.

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TWO NEW DRONGOS FROM THE PHILIPPINES

BY CHARLES VAURIE

During the course of a revision of the Dicruridae, in which large series were examined, two populations from the Philippines were encountered which differ from hitherto described forms. One is a race of *Dicrurus balicassius* and the other of *Dicrurus hottentottus*.

The latter, from Samar and Leyte in the southern half of the Eastern Province, I describe and name as:

Dicrurus hottentottus samarensis, new subspecies

TYPE: A.M.N.H. No. 672295; Rothschild Collection; adult male; Bonga, Samar, Philippines; June 7, 1896; Whitehead coll.

DIAGNOSIS: Similar to neighboring *striatus* from Mindanao and Basilan but with a shorter tail. The difference between the lengths of the central and outer tail feathers in *samarensis* is very slight or non-existent, so that the tail appears square, whereas in typical *striatus* there is always a shallow fork.

MEASUREMENTS OF THE TYPE: Wing, 131.0; central tail feather, 87.0; outer tail feather, 90.0; bill, 21.0.

RANGE: Samar, Leyte, and Panaon Islands, and, possibly, Bohol.

DISCUSSION: The material used for comparison consists of 59 specimens from Basilan, Mindanao, Samar, and Leyte.

There is no significant difference in the wing length between the various populations. (Only the measurements of fully adult specimens are given throughout this paper, the wing being pressed down flat and the bill being measured from the anterior border of the nostril.)

However, there is a well-marked difference in the length of the tail. The birds with the longest tail are those from Basilan, and the tail gets progressively

shorter from Basilan to western Mindanao and through eastern Mindanao, reaching a minimum in Samar and Leyte. There is a similar reduction in the differences in length between the central and outer tail feather. The birds from Basilan have a shallow fork which is completely lost in the birds from Samar and Leyte.

In the subsequent list of tail measurements the length of the central tail feather (C.T.F.) and of the outer tail feather (O.T.F.) are listed separately:

BASILAN

C.T.F. ♂: 97.0, 98.0, 100.0, 100.0, 100.0, 101.0, 104.0, 106.0 (100.75); C.T.F. ♀: 102.0, 103.0, 103.0, 103.0, 103.5 (102.90).

O.T.F. ♂: 104.0, 106.0, 107.0, 107.0, 109.0, 110.0, 112.0, 113.0 (108.50); O.T.F. ♀: 106.0, 108.0, 109.0, 111.5, 111.5 (109.20).

Difference between the C.T.F. and O.T.F. averages: ♂ 7.75, ♀ 6.30.

WESTERN MINDANAO

C.T.F. ♂: 94.0, 96.0, 98.5, 100.0, 105.0 (98.70); C.T.F. ♀: 96.5, 100.5, 102.0, 103.0 (100.50).

O.T.F. ♂: 101.0, 102.0, 102.0, 105.0, 108.0 (103.60); O.T.F. ♀: 103.0, 103.5, 105.0, 106.0, 106.5 (104.80).

Difference between the C.T.F. and O.T.F. averages: ♂ 4.90, ♀ 4.30.

EASTERN MINDANAO

C.T.F. ♂: 94.0, 95.0, 96.0, 97.0, 97.0, 98.0, 100.0, 100.0, 100.0 (97.45); C.T.F. ♀: 95.0, 97.0, 97.5, 100.0, 101.0, 102.0 (98.75).

O.T.F. ♂: 100.0, 100.0, 101.0, 101.0, 102.0, 103.0, 104.0 (101.57); O.T.F. ♀: 102.0, 103.0, 104.0, 104.0, 104.0, 105.0, 105.0, 110.0 (104.62).

Difference between the C.T.F. and O.T.F. averages: ♂ 4.12, ♀ 5.27.

SAMAR AND LEYTE

C.T.F. ♂: 87.0, 91.0, 93.0, 98.0 (92.25); C.T.F. ♀: 89.0, 89.0, 92.0, 92.0, 95.0, 97.0 (92.33).

O.T.F. ♂: 90.0, 92.0, 92.0, 99.0 (93.25); O.T.F. ♀: 93.0, 94.0, 94.0, 95.0, 95.0, 97.0 (94.67).

Difference between the C.T.F. and O.T.F. averages: ♂ 1.0, ♀ 1.29.

There is no overlap between the birds from Samar and Leyte on one hand and the populations from eastern and western Mindanao and Basilan on the other. Taking the female series which is more representative and considering the C.T.F. only, the measurements are: Basilan, 106.0–111.5 (109.20); western Mindanao, 103.0–106.5 (104.80); eastern Mindanao, 102.0–110.0 (104.62); Samar and Leyte, 93.0–97.0 (94.67). The difference between the means of the populations with the longest and shortest tail is about 15 mm., or 16 per cent.

This difference between the specimens is apparent even without taking measurements. In a series the short and perfectly square tails of the Samar birds stand out.

REMARKS ON THE DISTRIBUTION: I have been unable to locate Bonga where the type was collected. According to the "Pronouncing gazetteer and geographical dictionary of the Philippine Islands," 1902, there is a mountain of that name on the island, but I have been unable to find it. The "Gazetteer" also mentions that "Bonga" is the Spanish form of the native "Bunga" and that there are two settlements with the latter name on the northwestern coast of Samar. Neither of these appears on any map available to me, but one is said to be a "hamlet on the west coast of Samar, 4 miles southeast of Tarangnan" and the other a "town...in northeastern angle of bight, north of Mancaris Point, Canagualon Island lies off the town." As Whitehead is known to have sailed to Leyte from the northwestern coast of Samar, either one of these localities could be the type locality.

I have only two specimens from Leyte, one an immature, but the adult has the short tail, and as Worcester and Bourns (1898, "Contributions to Philippine ornithology. Part 2. Notes on the distribution of Philippine birds." Proc. U. S. Natl. Mus., vol. 20, p. 567) point out, "the islands of Samar and Leyte may be considered to form a continuous area, for the channel which separates them is very narrow and is dotted with numerous islets, so that it does not form an appreciable barrier." The "Gazetteer" (*loc. cit.*) states that the channel, "the Strait of San Juanico...has an

average width of 4320 feet but narrowing to 1500 feet. The soundings vary from 30 to 67 feet in the middle of the channel. Many little islands and shoals make this picturesque channel still narrower."

I have no specimens from Panaon, but the birds are probably the same as those of Leyte. Worcester and Bourns (*loc. cit.*) mention that other species collected there "point to a close relationship with Leyte, of which Panaon probably at one time formed a southern projection."

I have also no specimens from Bohol, and cannot be sure whether its birds will be found to be closer to *striatus* or *samarensis*. I believe they should be closer to the latter, as the channel which separates Bohol from Leyte is very shallow, according to Worcester and Bourns (*loc. cit.*), "the deepest sounding being but 22 fathoms," whereas great depths separate Bohol from Mindanao.

To summarize the distribution of *striatus* and *samarensis* as collected so far: to *striatus*, Basilan, Mindanao, Nipah; to *samarensis*, Samar, Leyte, Panaon, and probably Bohol.

The new race of *Dicrurus balicassius* is from the extreme northern provinces of Luzon and I name it:

***Dicrurus balicassius abraensis*, new subspecies**

TYPE: A.M.N.H. No. 672673; Rothschild Collection; adult male; Bucay, Abra Province, northern Luzon, Philippines; November 15, 1894; Whitehead coll.

DIAGNOSIS: Similar to neighboring *balicassius* from southern Luzon and Mindoro but with a longer bill and wing. In birds with fresh plumage, reflections of the metallic gloss purplish as compared with cool green in southern Luzon but equal in that respect to some specimens in Mindoro.

MEASUREMENTS OF THE TYPE: Wing, 151.5; bill, 25.5; central tail feather, 111.0; outer tail feather, 116.0.

RANGE: Known so far only from the northern provinces of Luzon: Cagayan, Ilocos Norte, and Abra. Intergrades with *balicassius* in central Luzon.

DISCUSSION: The material used for comparison consists of 58 specimens: one from Marinduque, 12 from Mindoro, including the type and paratypes of *D. b. mindorensis*, the remaining 45 being from Luzon.

The Marinduque specimen is in no way different from the birds of southern Luzon.

The Mindoro series measures: Wing: 6 males, 139.0–150.0 (143.66); 6 females, 138.0–147.5 (142.41). Bill: 5 males, 19.0–21.5 (20.56); 6 females, 19.3–22.5 (21.13). Outer tail feather: 5 males, 110.5–123.0 (116.40); 6 females, 114.0–120.5 (116.75).

The birds of Luzon from the southern end, up to and including Rizal Province, measure: Wing: 17 males, 133.0–146.0 (140.64); 10 females, 135.0–141.0 (138.75). Bill: 16 males, 19.0–22.0 (20.93); 11 females, 20.0–22.3 (21.41). Outer tail feather: 17 males, 109.5–122.0 (114.68); 10 females, 110.5–121.0 (114.75).

The specimens from northern Luzon (*abraensis*) consist of one female from Cape Engaño, another from Peñablanca, both in Cagayan Province, a male from Bangui in Ilocos Norte, and another from Bucay near Bangued in Abra Province. These specimens, all adults, measure as follows: Wing: male, 151.5, 156.5 (154.0); female, 148.0, 152.0 (150.0). Bill: male, 25.5, 26.5 (26.0); female, 25.5, 25.5. Outer tail feather: male 116.0, 122.0 (119.0); female, 113.0, 115.0 (114.0). The gloss also tends to the purple as in some Mindoro specimens, except that this tendency is more pronounced, the purplish reflections being quite strong in some specimens.

My series from northern Luzon is admittedly small, but the measurements are

consistent, and even without paying too much attention to the reflections of the gloss, the wing length is very definitely longer and that of the bill especially is not even closely approached by any Mindoro or southern Luzon specimens. These bill measurements are:

Mindoro (all specimens): 5 males, 19.0–21.5 (20.56); 6 females, 19.3–22.5 (21.13).

Southern Luzon: 16 males, 19.0–22.0 (20.93); 11 females, 20.0–22.3 (21.41).

Northern Luzon: 2 males, 25.5–26.5 (26.0); 2 females, 25.5, 25.5.

REMARKS ON THE DISTRIBUTION: This form probably ranges all through northern Luzon; from the Lingayen Gulf down, it probably intergrades with *balicassius*. Two specimens from Bayambang, a little south of the gulf in Pangasinan Province, have a bill that is intermediate between that of *balicassius* and *abraensis*.

The majority of the specimens examined are from the collection of the American Museum of Natural History; for the remainder I am indebted to the kindness of Dr. Herbert Friedmann of the United States National Museum who made available among other specimens the type and paratypes of *D. balicassius mindorensis*. To the authorities of the Museum of Comparative Zoölogy, the Academy of Natural Sciences of Philadelphia, and the Chicago Natural History Museum I am also indebted for the loan of additional material, as well as to Mr. Dean Amadon for a freshly collected specimen.

To Dr. Ernst Mayr, for reading the manuscript and for friendly advice and criticism, I am especially grateful.

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A STUDY OF ARMY-ANT LIFE AND BEHAVIOR UNDER DRY-SEASON CONDITIONS WITH SPECIAL REFERENCE TO REPRODUCTIVE FUNCTIONS

1. SOUTHERN MEXICO

By T. C. SCHNEIRLA¹

INTRODUCTION

It is probable that the bulk of our literature on the behavior of animals in tropical forests has arisen from observations made during the season of rains, the time when activities tend to be at their peak and most accessible to study. This holds widely for the indigenous insects and particularly the social insects, most of which tend to operate at a depressed level during the dry months in their reproduction as well as in activities such as foraging and construction. Yet the fact seems to be that under the ecological conditions then prevalent, behavior is not simply depressed but may show variations which are significant in comparison with the more effulgent rainy-season patterns. An investigation of the leaf-cutter ants from this angle should prove worth while. For the army ants (American *Eciton* species of the subfamily Dorylinae) the findings of the present study indicate that dry-season observations lend valuable assistance to an understanding of the characteristic behavior pattern.

The writer has outlined what appears to be the fundamental structure of the eciton behavior pattern from a series of investigations carried out with species of *Eciton* (*sensu stricto*) under rainy-season conditions (Schneirla, 1933, 1934, 1938, 1944). Members of this subgenus (at least during the rainy months in which the previous

surveys were made) are truly terrestrial in their foraging and nesting, much more accessible for behavior and general biological study than are the more or less subterranean species of other subgenera such as *Labidus* and *Acamatus*² (= *Neivamyrmex*). In the time of rains the eciton pattern appears in what may be roughly termed its optimal or most vigorous form, in that the chief activities of organized raiding and nomadic movement then are observable at their maximum. We are concerned here with what variations may occur in this system of activities under dry-weather conditions.

The central feature of the representative eciton behavior pattern in the rainy season is the regular alternation of two distinctive behavior modes in a colony: (1) the *nomadic*, in which large daily raids occur, each terminated by a change of nesting site at the day's end; and (2) the *statory*, in which the daily raids are reduced in vigor (or, as in *Eciton burchelli*, may not occur on certain days), and there is never a change in nesting site. Contrary to the prevalent earlier assumption that eciton nomadic movements are caused by a scarcity of food, the writer has found that control of the highly complex process of shifting reciprocally from one phase to the other of the nomad-statory cycle lies in events internal to the colony rather than external (Schneirla, 1938, 1945). Our evi-

¹ Fellow of the John Simon Guggenheim Memorial Foundation. The American Museum of Natural History and New York University. This investigation was supported by a grant from the Committee for Research in Problems of Sex, National Research Council.

² Although Borgmeier (1940) has renamed this subgenus *Neivamyrmex* because of a taxonomic pre-emption of the name *Acamatus*, no desirable purpose will be served by discarding the familiar name in this paper.

dence shows convincingly that the regular variations in colony behavior do not occur in accordance with external conditions such as food supply—for in the rainy season other insect life, the main source of eciton food, is everywhere abundant in the forest—but according to the internal presence or absence of stimulation from the brood. This, a kind of “drive” factor (roughly comparable to the energizing of an organism through visceral processes), has its principal source in the activities and chemo-stimulative properties of a developing larval brood. A secondary source of similar “social stimulation” centers in a newly emerged brood of callow workers.

The above statement does not reflect a disposition to neglect extrinsic factors in eciton behavior; rather it means that in the rainy season extrinsic factors do not account for the regular nomad-statory fluctuations. The fundamental controller of the colony behavior cycle we have traced to the reproductive cycle of the colony queen, which governs the time at which new broods enter into and pass from effectiveness as sources of “drive,” thus indirectly controlling colony behavior (Schneirla, 1944). If there is any extrinsic factor which times or which influences the timing of the regular ovulation processes of the *Eciton (sensu stricto)* queen, at present we have no indication of what it may be.¹ However, *a priori* it would seem possible that the cycle may be modified or even interrupted through changes in colony condition under deleterious external conditions such as prevail in the annual time of drought. Under these conditions both the size and the makeup of the brood may be affected, accounting for changes in the “drive” factor influencing the known behavior pattern directly and indirectly. Of the greatest importance are possible changes in the queen’s reproductive cycle, a known key factor.

¹ Recently Weber (1943) has suggested that lunar cycles may be involved as a control. This seems doubtful for two reasons in particular: first, my records show that new batches of eggs are not ordinarily delivered in a synchronized fashion by queens of different colonies in the same general area; and, second, while a sidereal period is 29.5 days, the eciton queen’s cycle is about 36 days in duration. The existence of species and individual variations in the length of this cycle remains to be determined.

There are, of course, environmental changes which can influence the behavior pattern directly. Two extrinsic effects of diurnal occurrence have been identified as important factors in the regular (i.e., rainy season) eciton behavior schedule. One is the effect of the first daylight in arousing the day’s raid of an (internally sensitized) *Eciton (sensu stricto)* colony, and, conversely, the effect of dusk in depressing predatory activities.² The other is the falling off of raiding activities which characteristically appears during the hours of midday, generally the warmest, driest, and brightest part of the day. Although at present the relative importance of these three atmospheric factors cannot be identified in accounting for the typical noon-time lull in eciton activities, the general evidence on insect activities and climatic conditions would encourage taking them all into account. The relative inhibition of army-ant activities under external conditions such as those prevailing at noon-time in the rainy season, conditions much more widely prevalent in the dry season, suggests an ecological behavior relationship of importance for our present study.

Numerous questions thus arise concerning what changes may appear in the eciton behavior pattern and its underlying processes under the influence of altered atmospheric circumstances and presumably reduced food supply typically prevailing in the tropical dry season. In addition to possible differences in the raiding and nomadic movements of a colony under dry-season conditions, we are interested in the internal condition of the colony and its reproductive processes in particular. While in the rainy months the nomad-statory rhythm prevails externally, it is traceable internally to the appearance at regular intervals of huge broods numbering tens of thousands of individuals and, as far as our results go, these are all worker forms. What happens to the reproductive func-

² This statement holds for the terrestrial species of the subgenus *Eciton (sensu stricto)*, our subjects in these investigations, which stage daytime raids; its applicability to the subterranean species in the other eciton subgenera is not known. However, contrary to a prevalent impression, no eciton species is “blind” in the sense that its activities are unaffected by a sensitivity to light (Schneirla, 1938).

tions of the eciton colony in the dry season, when and how the sexual forms are produced, how mating occurs and new colonies

originate, are all unanswered questions on which light is needed.

GENERAL NATURE AND AREA OF THE INVESTIGATION

Sumichrast (1868), author of the only previous paper dealing with the behavior of ecitons in Mexico, stated, "Thanks to the care with which these insects conceal their nests from view in the most solitary places it is probable that we shall learn only by chance about the winged sexes."

ison with conditions prevailing in the season of rains.

For two principal reasons the general area chosen for this investigation was southern Mexico. First of all, it was desirable to survey eciton conditions in localities in which the rainy and dry seasons

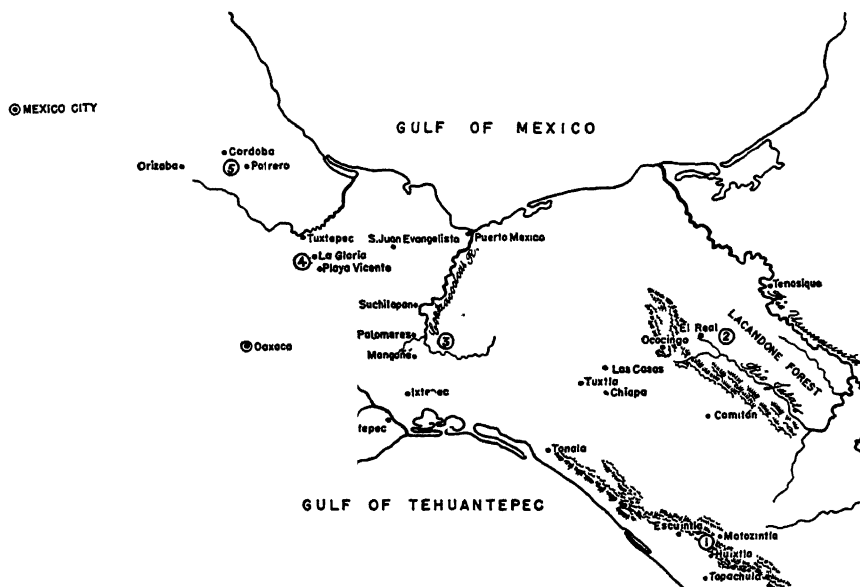


Fig. 1. Map of the isthmus section of southern Mexico, to show the principal localities of the present study. Areas 1 and 2 are in the State of Chiapas, area 3 in the State of Oaxaca, area 4 in Oaxaca near the Vera Cruz border, and area 5 in the State of Vera Cruz.

This complaint is a familiar one to those who have tried to find army-ant bivouacs; they are not easy to locate under any conditions, and, as this study shows, especially in the dry period. The principal aim of this investigation was to find eciton colonies in a variety of localities in the dry season, in order to discover what changes might exist in the form of their activities and in their internal condition in compar-

are well differentiated (Arias, 1942), and this condition is fulfilled in the portions of the States of Chiapas, Oaxaca, and Vera Cruz in which eciton colonies were examined. Furthermore, in this part of Mexico are located large areas of tropical rain forest, the habitat of the terrestrial *Eciton* (*sensu stricto*) species to be investigated.

The general schedule of the study was as follows: (1) the southern Pacific mountain

slope of the State of Chiapas in the Huixtla-Escuintla area, December 12, 1944, to February 10, 1945, with a resurvey in late March and early April; (2) the Atlantic slope forest of Chiapas in the Jetjá-Lacandone area east of the upper Jatatá River, February 26 to March 18, 1945; (3) the Modelo area of the upper Coatzacoalcos River, northeast of Mogofé in the Tehuantepec Isthmus of the State of Oaxaca, April 17 to 25, 1945; (4) the La Gloria area in the State of Vera Cruz southeast of Tuxtepec, April 29 to May 1, 1945; (5) upper Atoyac River near Potrero, and the upper Metlac River above Fortín, Vera Cruz, May 10 to 15, 1945.¹ The general

¹ It is not possible to express my thanks here to the many good people in Mexico who assisted the investigation in various indispensable ways. Among

location of these areas is indicated on the map in figure 1. Eciton colonies were sought out in each place, their current activities (condition of raiding, possible colony movements) investigated, and wherever possible colonies were captured for examination of their contents and preservation of their broods and fertile forms for later study.

those to whom I am especially grateful are: Dr. Manuel Martínez Baez, sub-Director of Health in the Mexican government; Dr. L. Figueroa Ortiz, Director of the hospital Centro Médico, Huixtla, and Sra. Figueroa Salano; Sr. and Sra. Enrique Knappe; Dr. E. Matuda and family; Sr. Joaquim Escobar; Mr. and Mrs. Dyfrig M. Forbes; Ings. Villas Perez and Humberto Ortega of Departamento Forestal y Caza; Dr. Alfonso Dampf; Dr. Franz Blom; Sr. and Sra. Jose Tarano. In this number should be included one especially zealous assistant, Sr. Carmelino Vargas of Huixtla.

RESULTS AND OBSERVATIONS

PRINCIPAL DATA ON CHIEF CASES STUDIED

There follows a summary of the data on the principal colonies studied, in chronological order. For each colony are given data on the locality and general conditions, the situation and activities of the colony, general condition of the brood or broods, and the condition of the queen at the time of capture. To the description of each colony is added an estimate of its general activity phase at the time it was observed (see fig. 2). Statements about condition of the broods are based on study of preserved material. Unless otherwise stated, the date given is the day of etherization and capture.

COLONY A, *Eciton (Eciton) burchelli*²: Dec. 29, 1944; area I, 25 km. north of Huixtla, Chis., at 1700 meters. On steep rocky slope, moderately dry; light forest cover. Three swarm raids observed, each ending in a short bivouac-change movement, on successive days. When captured, bivouacked under base of small tree next to an overhanging rock, bivouac fairly well hidden. Two distinct broods present: (1) a large brood (i.e., estimated at 30,000 or more) of young worker larvae, a minor part newly hatched eggs; and (2) a large brood of newly emerged callow workers, a small part (2000-3000) still enclosed but mature pupae of workers minor. A single queen present, fully contracted; no

other sexual forms. On the basis of its behavior, in relation to the condition of its broods and queen, the colony was judged to be *nomadic*, and to have shifted from the stately condition a few days before, with the emergence of the main part of its pupal brood.

COLONY B, *E. burchelli*: Dec. 31, 1944; area I, finca La Victoria, 28 km. north of Huixtla, Chis., 1800 meters. In a moderately humid arroyo between two dry hills, near top of small wooded mountain. Moderate forest cover. Two successive swarm raids observed, without any bivouac-change movements. Bivouacked well back underneath a tree root which formed one undercut bank of a small gully, well covered. Two broods: (1) a very young larval worker brood containing a larger number of recently hatched eggs than the younger brood of colony A; (2) a nearly mature pupal brood, all members pigmented, but with no emerged callows. *Stately*. Estimated very close to entering a new nomadic period. Single queen, fully contracted; no other sexual forms.

COLONY C, *E. burchelli*: Jan. 25, 1945; area I (near rancho La Esperanza), 20 km. north of Escuintla, Chis., foothills of Sierra Madre Mts. at 600 meters. On a moderately dry hill, 80 meters from a small running stream. Forest cover fair. Two swarm raids observed on successive days; no bivouac-change movement. Bivouacked in hollow base of large tree which lacked external openings save two small holes used by eciton columns. Two broods: (1) a large brood of early worker larvae, a considerable portion of it newly hatched eggs; (2) a large brood of enclosed, pigmented, nearly mature worker pupae.

² Determinations by Dr. M. R. Smith.

Queen contracted; no other sexual forms. *Statory*, but close to new nomadic period.

COLONY D, *E. burchelli*: Jan. 26, 1945; area I, Sierra Madre Mts., 40 km. north of Escuintla, at 1300 meters. On floor of large, well-forested valley, ground and vegetation moderately dry; running stream nearby. Well-developed swarm raid in progress. Bivouac: colony clustered within a mammal burrow (running about 10 cm. below surface) at a point 4 meters from the entrance. One brood only: large brood of mature larvae still engaged in spinning, nearly all members partially enclosed. Queen contracted; no other fertile forms present. Just entering statory period.

COLONY E, *E. burchelli*: Jan. 23, 1945; area I, valley of Huixtla R. near Tuzantan, Chis., at 1500 meters. (Found and captured independently by Carmelino Vargas.) On rather dry slope, poor cover, 100 meters from small stream. Bivouac: in mammal burrow about 1 meter from entrance, 15 cm. below surface. Single brood of worker larvae about two-thirds mature. Queen contracted; no other sexual forms. Probably *nomadic*.

COLONY F, *E. (Eciton) hamatum*: March 3, 1945; area II, hills west of Jetjá, near Santa Cruz R., at 500 meters. On moderately moist hill, 100 meters from running stream. Large trees; fairly good cover. A vigorous column raid with three principal systems (cf. Schneirla, 1938); a bivouac-change movement in progress at 5:00 P.M. Bivouac: an exposed cylinder, hanging from one end of small log to the ground. Two broods: (1) a large brood of young worker larvae, a minor portion of it newly hatched eggs massed in packets; (2) a callow worker brood, with a small part of the worker minor pupae still enclosed. Queen fully contracted; no other sexual forms. *Nomadic*.

COLONY G, *E. hamatum*: March 9, 1945; area II, Lacandone forest near upper Jetjá R., at 600 meters. In moderately humid forest, fairly good cover, on slope near running stream. A single long raiding column, unbranched within 60 meters of the bivouac. Bivouac: within hollow buttress of large tree, close to trunk below ground level; completely hidden. Two broods: (1) large masses of eggs in packets, a minority of them recently hatched; (2) a large brood of fairly mature worker pupae, partially pigmented, fully enclosed. Queen contracted; laid no eggs within the two days following capture, evidently having finished the delivery of a mass of eggs a few days before. No other sexual forms. *Statory*.

COLONY H, *E. hamatum*: March 10, 1945; Lacandone forest, near upper Jetjá R., at 750 meters. In moderately humid forest, not more than 150 meters from running stream. A single long raiding column unbranched within 85 meters of the bivouac, used on two successive days. Bivouac: completely enclosed within large decayed log, its major part in a central hollow, with groups of workers and interspersed piles of larvae in numerous cells in the outer portion.

A single brood: a large brood of mature worker larvae, engaged in spinning, nearly all members partially enclosed. Queen *physogastric*; her gaster asymmetrically enlarged. *Statory*.

COLONY X3, *E. burchelli*: March 21, 1945; area I, garden of Centro Médico, Huixtla, at 100 meters. Fairly humid part of otherwise dry hill; sparse, variable cover; about 150 meters west of Huixtla R. A small swarm raid, which dwindled away at about 11:15 A.M. Same bivouac site during two days prior to capture. Bivouac: within central hollow and wall cavities of large decayed log (also in ground underneath) in center of sheltered gully. Single large brood of mature larvae, evidently all spinning, with more than two-thirds of them (in general, the larger sizes) well enclosed. No mature queen found, and no other sexual forms. Evidently just entering statory period.

COLONY I, *E. burchelli*: March 27, 1945; area I (finca La Victoria), 29 km. north of Huixtla, Chis., at 1600 meters. Near the top of a moderately dry hill, with fair cover; a running stream in valley 150 meters below. Two heavy swarm raids on successive days, with short bivouac-change movement between. Bivouac: a long curtain, exposed, but far under a large decayed log. A single brood of well-advanced worker larvae, approximately two-thirds mature. Queen contracted. *Nomadic*.

COLONY J, *E. (Eciton) vagans*: March 27, 1945; area I (finca La Victoria), 28 km. north of Huixtla, Chis., at 1800 meters. Near top of moderately dry hill, in small, fairly humid arroyo under good cover. No raiding observed on March 26; weak column raid March 27. Bivouac: distributed through outer wall of large decayed log, with clusters in bark debris below, all well out of sight. (This colony was first observed on March 26, when a few straggling workers were noted on the bivouac log.) Two broods: (1) packets of newly laid eggs in bivouac; other eggs laid after queen captured; (2) large brood of mature worker larvae in thin envelopes, many of the workers minor still spinning. Queen not *physogastric* but clearly entering or passing through an egg-laying period. (She continued to lay eggs for three days after capture, almost until her death.) *Statory*.

COLONY K, *E. (Eciton) rogeri*: April 3, 1945; area I (vicinity of rancho La Esperanza), 20 km. north of Escuintla, at 650 meters. At base of long hill in moderately dry area, under medium cover, only 20 meters from small running stream. Column raids observed on successive days, reduced to a minimum through the midday hours; bivouac-change movement on April 2, another in progress at 5:30 P.M. on April 3 just preceding capture. Bivouac: under a loose rolf of matted vines, thin rootlets, and leaf mold, within

¹ This was one of the five colonies whose bivouacs were completely ransacked without my finding any sexual forms. In four of these cases (two *E. burchelli*, one *E. vagans*, and one *E. praedator* colony) it is possible that a mother queen was present but somehow escaped; in one case (*E. praedator*, X4; see below) the presence of a queen seemed doubtful.

the remains of an old tree root, fairly well out of sight. A single large brood of well-advanced worker larvae. Queen contracted. *Nomadic*.

COLONY L, *E. rogeri*: April 4, 1945; area I (vicinity of rancho La Esperanza), at 700 meters. In dense thicket close to small river; a somewhat humid situation. Fairly active column raid, with two well-developed trail systems. Bivouac: mainly in a cluster within the narrow, elongated, central hollow of a massive decayed log. Circumstances indicated previous occupancy of this site for some days. Broods: (1) eggs and very young larvae, in packets in lower part of mass; (2) mature worker pupae, an estimated one-third (mainly workers major and larger intermediates) already emerged as callow workers. Queen contracted. *Statary*; evidently at point of entering a new nomadic phase.

COLONY M, *E. hamatum*: April 23, 1945; area III (10 km. east of Coatzacoalcos R.), at 350 meters. Near bottom of deep, narrow valley between dry hills, a somewhat humid area close to creek bed containing small pools of stagnant water. (General area dry, after weeks without rain.) Extensive raid and bivouac change April 22. Vigorous column raid April 23 with three principal trail systems; at 4:00 p.m. an exodus from the bivouac (incipient bivouac-change movement) dominating one principal trail. Bivouac: curtain mass well back under large log on stream bank. Single large brood of advanced worker larvae close to maturity. Queen contracted. *Nomadic*.

COLONY N, *E. hamatum*: April 23, 1945; area III (close to Coatzacoalcos R.), at 250 meters. On bank of fairly humid arroyo between very dry hills, close to running stream; moderately good cover. Daily column raiding on single trails; on three of six days used route unbranched for 40 meters or more along stream

bank. Bivouac: very wide, irregular low cylinder far beneath large fallen tree. Two broods: (1) a few packets of eggs, newly laid; (2) a brood of about 1000-2000 large (ca. 19 mm. long) pupae, all males, intermediate in development and enclosed in cocoons, well distributed through walls and interior of bivouac. Queen nearly maximally *physogastric*; laid thousands of eggs before her death two days after capture, and at death contained an estimated 8000 more. *Statary*.

COLONY O, *E. hamatum*: May 1, 1945; area IV, at 200 meters. In dry forest, mainly of palms, poor cover. Light rain fell on May 1, following weeks of drought. Column raid only moderately developed at 10:00 A.M., although with three principal base trails. Raiding dwindled away considerably after 11:00 A.M., when columns became thin and difficult to follow over the brightly lighted floor of the hot and dry forest. Bivouac: mainly hidden; an irregular cylinder, a portion above ground suspended from a low palm leaf which nearly covered it, a smaller part underground in mammal burrow near roots of same palm tree. A large brood of advanced larvae, all worker forms. Queen contracted. A single dealated *E. hamatum* male was found in the subterranean portion of the bivouac. *Nomadic*.

COLONY X5, *E. burchelli*: May 15, 1945; area V, above Fortin, Vera Cruz, near upper Metlac R. at 1100 meters. In moderately humid forest near river's edge, below dry rocky slopes; fair cover. A vigorous swarm raid. Bivouac: a large cylinder in a sizable underground erosion chamber covered by two close-fitting rocks. One brood only, a large brood of well-advanced worker larvae. No queen or other sexual forms found. *Nomadic*.

RECAPITULATION OF PRINCIPAL FINDINGS IN EXAMINING ECITON COLONIES

CONDITION OF THE BROODS

In all, the behavior, situation, and internal contents of 20 eciton colonies were examined, of which 18 were colonies of *Eciton* (*sensu stricto*) and two, *Labidus* species. Of the *Eciton* (*sensu stricto*) species, 15 were found to contain a single fertile queen each. These colonies included six *E. burchelli*, six *E. hamatum*, one *E. vagans*, and two *E. rogeri*. Of the 20 colonies, 19 had one or two relatively immense broods at the time of capture, estimated (in comparison with the bulk of rainy-season broods actually counted in previous studies) at 20,000 or more individuals in each case. The captures described above were made in all parts of the

dry season between late December and May, and furthermore all areas sampled were more or less subject to the characteristic seasonal depression of rainfall. It would appear that relatively immense broods can be maintained by the colonies of *Eciton* (*sensu stricto*) [and *E. (Labidus) praedator*] in a general environment in which atmospheric conditions and food supply (i.e., available insect life) must be far less propitious for general eciton activities and for reproduction than in the rainy season.

What is even more surprising, in their detailed makeup the broods of these 19 colonies were all similar in general to those of the many eciton colonies examined under

rainy-season conditions (Schneirla, 1944). All were relatively immense in numbers; furthermore, each brood contained individuals at approximately the same stage of development, and in every one of the 19 colonies the larval and pupal broods contained only worker types of individuals. Although the details of brood population cannot be presented here, it may be said from a survey of fairly large samples that these cases resembled populations of rainy-season broods in the following important respects particularly: each brood formed a continuous series, clearly unimodal

large brood samples are arranged on a biphasic curve according to the condition of their broods. Those with single broods of larvae are placed at successive intervals on the crest according to the modal body length of the respective broods, those with enclosed broods (i.e., mature and enclosed larvae, transformed larvae, young pupae, advanced pupae, or nearly mature pigmented pupae) with or without new broods of eggs or young larvae are placed along the trough phase on the same basis. In all respects this arrangement resembles that prepared from the data for 15 eciton (*E.*

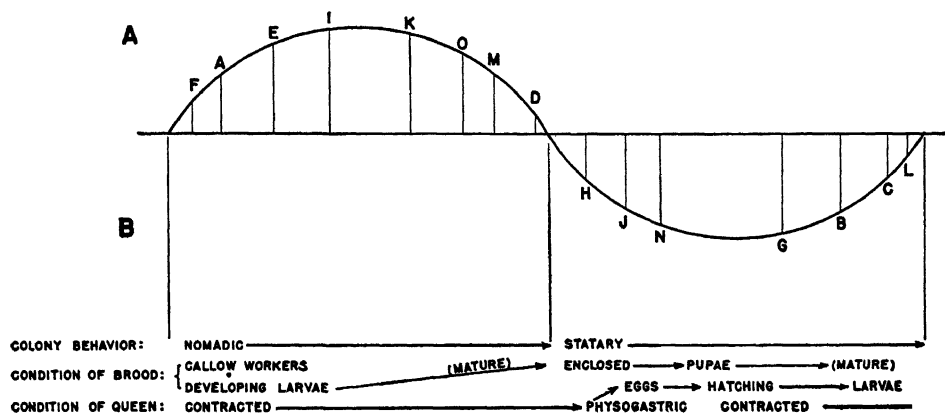


Fig. 2. Schematic diagram to represent the concurrence of events in the eciton colonies studied and captured in southern Mexico in 1945. In A, the crest of the biphasic curve represents the *nomadic* phase of colony activity and the trough represents the *statory* phase, with letters indicating the estimated places in the cycle reached by each given colony at the time of its capture. B indicates changing aspects in the behavior and internal condition of the colonies through parts of the cycle corresponding to the vertically coincidental points of A.

and tapering off to very small numbers at the extremes of maximal (major worker) and minimal (minor worker) sizes. Further similarities to rainy-season broods were noted; for example, in those cases (colonies A and F) in which pupal broods had been largely removed from cocoons as callow workers at the time of capture, the remaining enclosed portion was found to consist of the smallest sizes, workers minor. These facts are of importance not only for colony behavior, but also for questions concerning reproductive function which we shall want to consider.

In figure 2, the 15 colonies taken with their respective fertile queens as well as

hamatum) colonies studied in the rainy season of 1938 (see Schneirla, 1944, fig. 2). The clearest points are that: (1) colonies with broods of eggs or very young larvae also have enclosed pupal broods whose advancement is separated roughly by the same interval from the general growth stage of the early larval broods of the respective colonies; (2) when callow workers are present, there is also present a larval brood more advanced than that of colonies under point 1; (3) colonies that have broods of larvae beyond the growth point involved in 2 above have no other brood; and (4) colonies with newly enclosed mature larval broods have no other brood. These facts

all may be fitted into a common scheme of a reproductive rhythm (see fig. 2), based (as was that for the rainy season) upon the presumed delivery of new broods at regular intervals of time by a single queen in each colony. Thus, when two broods are present, their growth stages are synchronized, and the growth points of the respective broods fall into place as would be expected from the assumption of a rhythmic egg-delivery process.

There was only one exception to the predominance of worker broods—colony N, taken in the upper Coatzacoalcos area in late April. This colony had one brood exclusively of males (moderately advanced pupae) and a second brood of thousands of eggs just being delivered. The two broods of this colony were found synchronized in their growth stages much as were those of colonies in which only worker forms occurred in the broods.¹

CONDITION OF THE QUEENS

The condition of the fertile queens in our 15 completely surveyed colonies, as far as the occurrence of contracted or physogastric forms was concerned, also fits the scheme described from rainy-season studies. To emphasize the point, queens in the physogastric or egg-producing condition were found only in the three colonies (H, J, and N) possessing advanced broods in the early pupal condition. The pupal male brood of colony N included about 1000–2000 individuals; however, the queen delivered many thousand eggs prior to her death, and (judging from our previous case, 1944) then contained many thousands of unlaidd eggs. The remaining 12 queens all were contracted. From the timing of broods in the latter colonies, as indicated in figure 2, it would appear that the newest brood in each of these cases was delivered (as eggs) about the time when the given colony last possessed a brood entering its pupal development. The correlation of

broods described above, and the condition in which the respective queens were found, would hardly seem possible unless these queens had been maintaining regular ovulation rhythms of fairly constant phase duration. As far as our present facts go, they indicate that many, if not all, *Eciton* (*sensu stricto*) queens are able to maintain their characteristic reproductive rhythms throughout the dry period.

GENERAL FACTS CONCERNING COLONY BEHAVIOR

In considering colony behavior, first of all it must be remembered that this study was cross sectional in the sense that few of the colonies were under observation for more than two or three days, and some of them for only one day. Furthermore, colony behavior in the dry season is likely to be more irregular, and as we shall find more subject to extrinsic interferences, than in the rainy season, making longer observation periods very desirable. Despite these limitations, the facts check rather well through the series of cases. The colonies that have been termed *nomadic* on the basis of their more vigorous raids and the occurrence of one or more observed bivouac changes just preceding capture are F, A, I, K, and M; the colonies that may be termed *statory* on the basis of limited raiding and the non-occurrence of bivouac changes during one or more days preceding capture are B, C, G, H, J, and N. It will be seen that in each of these instances the observed circumstances of colony behavior coincided with the condition of the brood or broods, essentially as described on the basis of extensive rainy-season studies of *E. hamatum* and *E. burchelli* (Schneirla, 1938, 1945).

The five colonies that were observed and whose bivouacs were ransacked without any fertile forms being found deserve mention here. Two of these were the *E. burchelli* colonies X3 and X5, described above. In these colonies the condition of the brood (X3: mature larvae, mainly enclosed; X5: advanced larvae, not yet mature, unenclosed) and colony behavior (X3: weak raiding, no bivouac change; X5: vigorous raiding, bivouac change probable) corre-

¹ It should be noted, however, that the male brood of colony N seemed distinctly more advanced in pupation than have enclosed worker broods taken at the time the colony queen was engaged in egg laying. Although it is possible that the queen's rhythm in this case was somewhat irregular, a more likely explanation is that male broods develop faster than do worker broods.

sponds as described above. A correspondence between brood condition and behavior similar to that of colony X3 was observed also in an *E. vagans* colony (X2) that was studied at Jetjá, Chiapas.

This colony (X2) had a mature larval brood (all enclosed but still largely engaged in spinning), and on three successive days staged relatively weak raids leading from the bivouac over the same long base trail. During three days after it was found this colony remained in the same place, tenanting one side of a huge decaying log through an extent of about 2 meters, its workers and brood well distributed among numerous cells in the moist spongy wood. Soon after the investigation of this bivouac began, an *E. praedator* colony (X1) was discovered occupying similarly scattered cells on the other side of this same log (and excavations in the ground beneath), through nearly the same extent of length as the *E. vagans* colony. The *praedator* colony contained a great brood of newly transformed pupae, all workers, and an immense brood of eggs.¹

¹ It is unusual to find two eciton colonies bivouacked as close together as these were, with cells along their upper borders actually intermingled (i.e., some *vagans*-occupied cells in *praedator* territory, and vice versa). Despite a careful demolition and

It is probable that the fertile queens or dichthadiigynes of the above colonies were present but eluded capture. All of the situations were difficult to search; moreover, judging from the condition of the broods (cf. fig. 2) the queens presumably were contracted in all four cases, and could have escaped with agility and speed.

In only one instance, an *E. praedator* colony in Vera Cruz State (area IV), did the circumstances suggest that no queen may have been present at the time of capture. This colony was established in the deep and extensive subterranean excavations of a *Solenopsis geminata* nest from which it had evidently driven the original owners some time before. The eciton workers were in abundance in this nest, but only one evening raid was staged during three days of observation. An immense pupal brood was present, pigmented and well advanced, all members at nearly the same stage of development. However, no eggs were present, as might have been expected from the case of the *E. praedator* colony X1, which had two well-spaced broods when taken.

search of the entire log and the extensive *praedator* excavations beneath, no queens or other fertile forms were found.

TO WHAT EXTENT DO THESE RESULTS TYPIFY ECITON DRY-SEASON CONDITIONS?

In view of the fact that the survey involved numerous well-separated areas and sampled a variety of ecological situations ranging from fairly humid to very dry, from low to high altitudes, and extended through almost all of the dry period, it is probable that in general the results portray fairly well how eciton colonies pass through the dry season. The predominance among our cases of huge broods entirely of workers, spaced in their time relations much as was found in Panama under rainy-season conditions, indicates that eciton queens can maintain their reproductive functions on much the same rhythmic basis during both the rainy and dry times of year. Correspondingly, our findings show that in the dry months colony behavior may fluctuate between nomadic and statary phases much as

it does in the time of rains (Schneirla, 1938, 1945). This picture very probably represents the basic trend of events, yet we must consider the possibility that important variations characteristic of the season may well be passed over in a cross sectional survey such as the present one.

For example, although there are numerous reasons for believing that the fertile forms develop at some time during the dry period, we cannot add much here to the meager evidence on that score. Despite the fact that winged males of various eciton species were taken at lights from late February onward, male developmental forms were found in only one of 20 colonies whose bivouacs were thoroughly inspected, and only one bivouac was found with a dealate male. Furthermore, no young queens were

brought to light in the bivouacs, only individuals that were clearly functioning as the single reproductive dichthadiigynes of the respective colonies.

Circumstances such as these suggest that the development of sexual forms and their presence in eciton colonies as mature individuals must constitute a relatively brief episode in the course of dry-season events.

ARMY ANTS IN GENERAL RELATION TO DRY-SEASON CONDITIONS

That sustained dry weather exerts profound effects upon insect life is a well-known fact (Uvarov, 1931), although the rise and scope of such effects are still understood only in a preliminary way. With the exception of a few forms such as some orthopterans and, of course, ticks, insects in general are greatly reduced in their activity, particularly in the daytime. Most of the ants are held to a relatively low level, as compared with rainy-season functions. The army ants are no exception, as previous writers have noted. Smith (1858) quoted Bates on an observation of *E. drepanophorum* (= *E. hamatum*) traveling in a column he considered not a predatory but a true migratory movement. Bates' reasons for so thinking are of interest: "The procession was not a predatory affair, because all of the small-headed individuals conveyed in their mandibles a little cluster of white maggots, probably larvae of their own species. I have no doubt of its being a migration, as at the time of observation a change of season was taking place, the river retreating from the beach, and the open places above, about to be burnt up by the hot sun of the dry season."

Although the circumstances support Bates' identification of this movement as a change of bivouac, the season of occurrence is not at all a useful clue, for we have found that bivouac-change movements occur during the dry season much as in the time of rains. However, certain behavior differences are notable.

Our survey shows that while there is apparent no radical qualitative change in eciton colony behavior with the coming of the dry season, the activities of colonies

It may be suggested also that broods containing the sexual forms must be very limited in number in any given colony, and that some colonies may fail to produce any broods of such individuals. Only a study of events in given colonies over considerable periods of time can readily clarify these matters.

may undergo a considerable general reduction in vigor with limited qualitative changes resulting. However, the literature contains certain misconceptions concerning the nature and degree of such changes. A frequent one is that raiding and other movements are suspended almost altogether during the dry season. For example, in Sumichrast's (1868) discussion of Mexican army-ant behavior, based especially on notes from the Potrero area below Cordoba when a flourishing tropical forest existed there, it is stated that: "Beside the changes of domicile, which are so generally in relation with the atmospheric variation as to serve as a rule to the inhabitants of the country, the *Eciton* devotes itself every season to excursions for pillage . . . invading the habitations of the country. These visits ordinarily take place at the beginning and the end of the rainy season, and almost always during the night." Without interpretation, such statements readily give rise to misconceptions. Observations of this kind, typical as they are, depend mainly upon eciton raids noticed near inhabited places, and are influenced by the swarm-raiding activities of *E. (Labidus) praedator* in particular. It is a fact that colonies of this species, commonest of the subterranean ecitons (in the subgenera *Labidus* and *Acamatus*) to be seen, are far more likely to range outside rain forest areas and in clearings than are the colonies of terrestrial *Eciton (sensu stricto)* species. Our own notes show that, although *praedator* raids invade settled places much less frequently during the dry months than in rainy times, such raids do occur, especially in early morning or in evening or after a

general increase in humidity. Their raids are seldom witnessed in dry times, not because conditions render the ants altogether inactive, but because eciton swarms do not readily cross the open, dry, and generally dusty areas (with scanty subterranean routes) commonly encountered around villages and haciendas.

On numerous occasions in different localities variations in the prominence of *praedator* activities according to atmospheric conditions were noted. For instance, during a seven-hour hike up the Huixtla River Valley on April 10 in the morning and early afternoon, no eciton raids were encountered. Throughout the day the atmosphere was dry, the trail dusty and exposed to bright sunlight except in occasional patches of forest. When I returned next day over the same route, the air was humid and the sky overcast after a light but prolonged rain on the previous evening. Then the well-thronged columns or swarms of five different *E. praedator* colonies were seen, and in one forested ravine an *E. burchelli* raid was observed. As another example, for two days in early February I hunted ecitons in the fairly well-forested but dry valley of La Esperanza (area I) without success; yet on the third day, after a light rain during the night, four raids (of *Labidus* and *Acamatus* species) were encountered during the morning, and two others in late afternoon.

It is interesting to note that natives in different areas commonly accept eciton raids as an omen of rain. According to von Ihering (1894) *E. praedator* is known in Brazil as the "rain ant," because of the frequency with which its raids are noticed shortly before heavy rains. The basis of this fact is readily understandable, for we should expect that (in addition to atmospheric changes) the darkening which commonly precedes rain would account for increased *praedator* activities in open areas where the ants would be noticed. However, in the present writer's experience with eciton activities, such spurts in raiding are better indicators of rain-just-past than of rain-to-come. In any case, a distorted picture of eciton activities is certain to result if we rely upon impressions obtained

from encounters with species such as *E. praedator* outside the forest.

THE DRY-SEASON ACTIVITIES OF TERRESTRIAL ECITON SPECIES

For the terrestrial ecitons, our major interest in this paper, we have activity records representing the greatest part of the dry season, taken from a variety of localities and ecological situations in the forests of southern Mexico. In the first place, it may be said in general that colonies of the *Eciton* (*sensu stricto*) species are able to continue both their daytime raids and their bivouac-change movements throughout the dry months. Our evidence shows that the vigor of the diurnal raids and the occurrence or non-occurrence of bivouac-change movements then fluctuates much as in the rainy season (Schneirla, 1938, 1945) according to internal changes dependent upon condition of the brood.

However, extrinsic conditions exert a much greater influence in the dry season in accounting for behavior irregularities in given colonies. The raids tend to be smaller in dry situations, even in colonies identifiable as nomadic (i.e., maximally excitable). In the wet season, colonies of *E. hamatum* may be depended upon to stage definite daily raids (even when statary), with their columns generally in full view on the surface; however, under dry-season conditions statary *hamatum* colonies sometimes go raidless on given days, and nomadic colonies often stage rather small raids. Furthermore, in dry situations or under sparse forest cover *hamatum* columns frequently slip beneath leaves and other objects even for considerable distances, as *E. rogeri* and *vagans* columns do far more frequently. The midday lull in raiding, a regular feature of the daily routine in rainy months (and an important factor in the development of a colony removal at the end of a raid), is much more pronounced and lasts longer in the dry period, sometimes to the extent that raiding is suspended altogether through the noonday hours.

Another species on which extensive notes are available is *E. burchelli*. While in the rainy season colonies of this species pass numerous raidless days in the central part

of the statary period (Schneirla, 1945), daily raids occur regularly when a colony is nomadic. In the dry season the reduction is much greater, and raidless days sometimes occur even in *burchelli* colonies whose internal (brood) conditions fit the picture of nomadism. Of interest is the fact, to be expected from this, that under such conditions *burchelli* colonies which ostensibly are nomadic do not always stage bivouac-change movements. That is, a return to the same bivouac ensues, rather than a removal over raiding trials, towards the end of a given day on which the raids are notably underdeveloped.

The failure of bivouac-change movements when raids are small is a result to be expected from our theory of the relationship between raiding and bivouac change (Schneirla, 1938), accounting for the latter occurrence as an outcome of large raids in a maximally (internally) excited colony. Our evidence tends to suggest that in the dry season the inhibiting effect of external conditions frequently counterbalances the stimulative effect of internal "drive," so that a colony internally fitted for nomadism may fail to move. This may well be a matter of considerable importance for colony survival.

Most of the record colonies described in the preceding section were studied and captured when in more humid situations under fairly good cover; few of them in very dry, exposed areas.

In the driest forests (e.g., area III, area IV) eciton colonies were most difficult to find, not only because their raids were encountered much less frequently than in more humid areas (e.g., area II), but also because the bivouacs when discovered were likely to be unassailably secluded below great rocks or tree bases, or in the recesses of dry, hard ground.

For three days during April of 1946 the writer hunted ecitons in the Potrero area, in which Sumichrast (1868) worked. Both the valley, which is now almost completely denuded of forest except for narrow strips along the Atoyac River, and the low bordering mountains, which are losing their sparse forests through progressive clearing, were at the time sweltering in the heat of a

protracted drought. No traces of army ants were discovered, although when the search shifted to the far more humid vicinity of the Metlac River above Cordoba, a colony of *E. burchelli* was found on the first day.

One evident reason why searches for eciton colonies in dry areas often are fruitless is that raids tend to be smaller or less frequent, and the columns thin and partially concealed in such localities. Under such conditions the colonies are likely to be missed unless a rain or an occasional dark misty period accounts for a spurt in extra-colony activities. Because we lack evidence on the internal conditions and behavior of colonies which happen to pass considerable periods in very dry localities, nothing can be said here concerning possible interruptions or distortions of the regular eciton rhythm in reproduction and behavior in such cases. It should be noted that certain behavioral factors which operate in normal raiding serve to keep colonies out of very non-optimal situations in a diversified environment. In general, the pushing parties of column-raiding species and the large bodies of swarm-raiding species advance more readily into humid places affording a fair supply of booty than into spots which are dry, brightly illuminated, and sparse in booty. Such matters have been touched upon in a previous connection (Schneirla, 1938). Since bivouac-change movements follow main routes developed in raiding, army-ant colonies evidently adjust fairly well to dry-season conditions by operating and settling more frequently in fairly optimal zones such as ravines than in drier and more exposed parts of their environment. Even so, the latter possibility should not be overlooked as an ever-present hazard.

There is one way in which eciton colonies conceivably are "caught" for considerable periods of time in non-optimal situations where they may lose heavily in numbers. This possibility arises through the fact that normally a colony is not mobile or nomadic unless adequate intrinsic (i.e., brood) excitation exists. Let us say that a colony with a brood of mature larvae bivouacs in a fairly humid arroyo in the last move of a

given nomadic period. With this brood enclosed the colony becomes statary or sessile, and presently the general area dries out. On the basis of its current internal condition the colony cannot escape. From our evidence, only local shifts through short distances might occur in response to the irritating effects of bright light or high temperature, taking the bivouac cluster deeper into subterranean cavities or farther beneath objects such as large rocks or logs but not out of the given area. Under such conditions raids would diminish in scope and frequency, further reducing the supply of moisture available through food. Since laboratory tests of a preliminary nature indicate that the desiccation tolerance of eciton workers is fairly low, it is possible that through circumstances such as those outlined above many colonies suffer drastic reductions in personnel or even extermination.

Although on the whole eciton colonies seem to operate fairly effectively in the dry season, notwithstanding hazards such as that just discussed, in the general literature there has been a tendency to regard doryline nomadic movements as subject to complete suspension during the dry months (Brauns, 1901; Santschi, 1908). To be sure, certain records do suggest that a halt in activities may occur in groups living outside the tropics. For instance, Wheeler (1900) reported for the *Acamatus* species of Texas a tendency to suspend the "ancestral nomadic condition" during winter and early spring, when the same nest site is occupied during an extended period. As evidence for a spring re-arousal, he observed an *E. (A.) schmitti* colony on the march May 1, and at other times saw colonies moving in files at about that time, indicating to him that in spring these species leave their winter quarters to resume their marauding expeditions. Less definitely, Santschi (1908) stated that although *Dorylus* migrations are of general occurrence they are not obligatory, and under certain conditions these ants may inhabit the same nest for long periods of time.

If such observations hold for species which have adjusted to conditions outside tropical zones, our evidence on the other

hand indicates that colonies of the tropic dwelling ecitons, i.e., *Eciton (sensu stricto)* in particular and probably the others as well, do not conform. We have found that colonies of the terrestrial army ants become mobile or nomadic at given times in the dry season, under the influence of much the same factors which arouse their nomadic movements during the season of rains. In the areas surveyed in this study, no evidence was found for a dry-season suspension of eciton momadism, although, as we have mentioned, an occasional daily failure of bivouac change may occur in an otherwise nomadic colony. The possibility nevertheless remains that longer suspensions may come about in exceptionally non-optimal situations or under special reproductive conditions as yet unknown.

A HORIZONTAL SHIFT IN THE LEVEL OF NESTING

The bivouacking of tropical ecitons is affected strikingly by dry-season conditions in what may be termed the horizontal level of the sites, if not in duration of occupancy. Under the conditions generally prevalent in southern Mexico during the period of this study, colonies of the ordinarily terrestrial eciton species tend to form their clusters in subterranean places rather than on or above the surface, as in the rainy season (Schneirla, 1938). Their rainy-season bivouacs are found almost invariably above ground: those of nomadic colonies ordinarily exposed (e.g., clustered between the buttressed roots of a tree), those of statary colonies concealed as a rule and in elevated situations (e.g., the upper interior of a hollow tree). In the dry season even nomadic colonies may go below ground, to form their clusters in cavities such as mammal burrows or spaces beneath rocks or vegetation. Atmospheric conditions apparently have much to do with the change, for surface bivouacs are found with greater frequency in more humid localities (e.g., our area II). Colonies entering the statary condition tend to move into more secluded, better covered niches than do nomadic colonies. In moister places they are found well ensconced in the recesses of large, decaying logs; in drier places the

bivouacs frequently are in relatively inaccessible subterranean cavities.

The fact that our present evidence concerning colony behavior almost altogether

concerns colonies with large worker broods raises the question of when and how the sexual forms are produced, and how their occurrence influences colony behavior.

THE PROBLEM OF FERTILE ECITON INDIVIDUALS

THE PRODUCTION OF MALES

Among ants it is generally true that the sexual forms are produced seasonally at times characteristic of given species. In the temperate zone, the males and females of certain species such as *Prenolepis imparis* appear in the spring, those of others such as *Formica incerta* during the summer (Talbot, 1945). For the dorylines, one may gather from the fragmentary evidence available that males and young queens are produced at some time during the dry season. The present writer found no fertile forms in eciton broods during four annual periods of rainy-season investigation in Panama (Schneirla, 1938).

The evasiveness of this problem is expressible by the fact that the wasp-like males of both Old and New World dorylines were taken independently at lights and were given separate taxonomic standing long before their affinity with corresponding worker forms had been established (Wheeler, 1921). Since the time when Savage (1849) found dealated males marching in a column of *Anomma nigricans* workers, both by inference and by direct observation the species affiliations of a long series of doryline males have been identified (Sumichrast, 1868; Müller, 1886; Mayr, 1886; Emery, 1896; Wheeler, 1921; and Smith, 1942). However, the conditions under which males are produced are still virtually unknown.

In a number of scattered instances, males have been discovered in doryline nests as immature forms or as mature winged adults. In Paraná, Brazil, Hetschko (Mayr, 1886) found a colony of *E. (Acamatus) hetschko* occupying subterranean galleries in which a number of winged males were found amid the workers. On April 12, 1914, Gallardo (1915) discovered a nest of *E. (A.) spegazzinii* established beneath the patio tiles of his home at Bella Vista in the

Argentine, and in digging it out a compact group of about 50 males was discovered in one section of the subterranean chambers. On October 23, 1916, Luederwaldt (1918) investigated a large colony of *E. (L.) praedator* established in an old termitarium in a garden at São Paulo, Brazil, finding enclosed worker pupae as well as numerous open cases 20 mm. in length from which males evidently had emerged. (Incidentally, the queen was physogastric and masses of newly laid eggs were found, a state of affairs which fits our scheme of the eciton reproductive rhythm.) Hubrich, as reported by Bruch (1924), took numerous male pupae in cocoons from a nest of *E. (A.) hetschko* found in the Alta Gracia Mountains of Argentina.¹

All of the above cases involved species of the subgenera *Labidus* and *Acamatus* (= *Neivamyrmex*), which frequently emerge from the forest into clearings. The terrestrial species of *Eciton* (*sensu stricto*), virtually never found outside the bounds of rain forest, have been discovered with male broods only twice, to the writer's knowledge. At the Kartabo station in British Guiana on July 18, 1920, near the end of the rather irregular rainy season of that locality, Wheeler (1921) and Emerson found a colony of *E. burchelli* which contained a brood of more than 100 nearly full-grown male pupae in cocoons. The lot of male pupae represented a distinct brood, which evidently contained no worker forms.²

The second instance is our *E. hamatum* colony N, taken on April 23 near the upper Coatzacoalcos River, in which was found the only male brood present in any of the 20 colonies captured in the present study. This was an all-male brood of somewhat

¹ Date of capture not given in original.

² Dr. Emerson has assured me that no worker pupae were found with this brood.

more than 1000 pupae, enclosed and well advanced in pupation. The single queen was physogastric with many thousands of eggs already laid towards a further brood.

From these scattered facts certain conclusions may be drawn very tentatively. First, although we shall not use space here to check local seasonal changes with the dates given above, from fragmentary evidence we may conclude that eciton males probably develop at some time during the dry season. The evidence at hand further suggests that the males develop in distinctive and relatively small broods of this one sex alone. And although exceptional conditions must be required to produce a male brood, a few facts intimate that these broods may well appear at regular points in the eciton reproductive cycle when worker broods might otherwise come. At any rate, in the *E. praedator* colony of Luederwaldt and the *E. hamatum* colony N of the present study, the presence of masses of eggs in addition to the brood of advanced male pupae seems to represent a coincidence of broods which agrees closely with the synchronization holding for the reproductive cycle under rainy-season conditions (Schneirla, 1944).

THE PROBLEM OF DORYLINE QUEEN PRODUCTION

To our previous evidence that one queen only is present in the established eciton colony (Schneirla, 1944), 15 new cases may be added from the present study, making a total of 34 *Eciton (sensu stricto)* colonies of five different species from which single dichthadiigyne individuals have been taken by the present writer. Furthermore, among the 15 colonies of this subgenus from which queens have been captured by others, with but a single exception only one queen was found in each instance, and single queens have been found in nearly all colonies of other eciton subgenera from which captures have been made. From these results it would appear that in the event more than one individual of this caste is found in an eciton bivouac, we are dealing with a relatively temporary condition involving one or more new queens.

It should be emphasized that finding a queen in the contracted condition cannot be accepted as evidence that she is a "young," newly emerged, and not yet gravid individual. We have made it clear why dichthadiigynes have been discovered in the contracted condition in most instances. Our evidence (Schneirla, 1938, 1944) establishes the existence of a reproductive cycle in the *Eciton (sensu stricto)* queen, in which she becomes gravid at recurrent but relatively brief intervals, but otherwise remains contracted. Circumstances indicate that the condition holds more or less in the other subgenera as well. Cases are very rare in which eciton queens have been captured under conditions definitely establishing their recent emergence.

To the writer's knowledge, in only one instance on record has an *Eciton (sensu stricto)* colony been found with at least one evidently "new" queen. This was at the Kartabo station in British Guiana, on July 19, 1920, when, as mentioned above, Wheeler (1921) and Emerson found a colony of *E. burchelli* with a brood of nearly mature male pupae. When the colony was being smoked out of its hollow tree bivouacking place, "... Mr. Emerson observed a large halting mass of workers in the column and on thrusting his tweezers into it drew forth a young queen which was being very slowly piloted along by a dense cloud of attendants. At 3:00 P.M. a second queen, precisely like the first, was discovered in one of the masses of ants resting on leaves a few yards from the tree." Wheeler (1921) reasoned that, "the two females had evidently recently emerged for their colors were very brilliant and the delicate golden pile on their bodies was intact. Moreover, their ovaries were undeveloped as shown by the relatively small size of the gaster."

Unfortunately, we cannot be sure about the youth of either queen in this instance. The mother queen may well have escaped in the *melée*, or may have died previously as Wheeler thought, leaving two new queens; or, one of the supposedly "young" individuals actually may have been the older dichthadiigyne in a contracted state. In *Eciton (sensu stricto)* queens, a "fresh" appearance may be a deceptive clue to age.

According to the present writer's theory the mother queen would be anticipated in the contracted state under the brood conditions described in Wheeler's Kartabo colony, i.e., in an eciton colony with a nearly mature pupal brood the fertile queen would not ordinarily enter a new egg-delivery phase for a least three additional weeks (Schneirla, 1938). Yet, since the monogynic condition seems to hold in eciton, it is probable that at least one of these queens was new.

Two instances are on record for the other eciton subgenera. In late March and early April, of 1899, near Austin, Texas, Wheeler (1900) discovered two different colonies of *E. (Acamatus) schmitti*, each with one queen. One of these queens was physogastric and died on April 18, a week after capture, having laid nearly all of her eggs; the other (more nearly contracted) continued to lay eggs from time to time in the artificial nest, but altogether laid very few. Then, in the midst of the mass of workers with which the two queens had been placed, on April 20 a new queen was found, intermediate between the first two in size and appearance. Wheeler (1900) thought this individual could not have been overlooked in the first examination of the colony, and hence "must have developed within the nest during less than a month from an insect closely resembling a worker in size and appearance. The workers must have been feeding her abundantly." It is a reasonable inference that the queen last found was a young individual. However, she may have been in the colony when it

was captured, since it is not at all impossible to overlook a contracted queen in the midst of active or clustered workers.

The engineer Ogloblin sent to Carlos Bruch (1934) two queens of *E. (N.) hetschkoi ogloblini* found in the Argentine on October 20, 1932, in the same nest beneath a stone. Both queens were contracted; however, eggs were present in the nest, and when the captures were placed in an observation nest one of the queens was observed depositing eggs. The other queen laid no eggs, and "appeared to be virgin," although "neither of the two presented the characteristic signs of gestation."

From none of these three instances is it clear how the supernumerary queens were produced. The meager evidence carries the suggestion that whether queens appear in worker broods, with males, or in special broods exclusively containing queens, only a few of them are produced at one time. Since they are wingless, and very attractive to the workers, it is probable that they do not leave the colony readily; hence if their number were very large, they would be taken in the bivouacs more frequently and in greater numbers. In the present study 20 colonies were examined in the dry season, without one being found with queens other than its single fertile individual. It is possible that the production of dichthadiigynes in a given colony occurs under conditions even more exceptional than does the production of males. The specific conditions of queen production and their season of maturation remain to be discovered.

SUMMARY AND DISCUSSION

The dry season appears to bring no very radical changes in the life of army ants, perhaps fewer important changes than with most other insects. Atmospheric conditions commonly inhibit their raiding to some extent, particularly through midday, when the typical slack period is generally more pronounced than in the rainy season and sometimes approaches a stoppage. However, the ecitons do not appear to enter a resting or dormant condition as a regular

response to dry weather. The colonies encountered in southern Mexico in the course of the present study approximated rainy-season conditions more closely in their internal condition and behavior than the present writer had expected. In fact colonies of terrestrial eciton species have been found capable of staging daily raids and carrying out nomadic movements even in rather dry forest areas.

The apparent success with which army-

ant colonies adapt to adverse dry-season conditions evidently depends upon two mechanisms in particular. First, by virtue of their typical responses in raiding and in the subsequent bivouac-change movements colonies generally manage to remain in the vicinity of more optimal zones such as ravines. The basis is a crude selective process arising through the tendency of advance raiders to be influenced somewhat in their movements by variations in illumination, humidity, and booty supply—obviously a major factor influencing the path of territorial change since the eventual bivouac-change movements of a colony follow the main lines of its raiding. A second important mechanism of adaptation to dry weather in ordinarily terrestrial species is the tendency to withdraw into moist and dark recesses, and underground places in particular, when the surface terrain is dry. This variation in bivouacking clearly depends upon atmospheric conditions, since in humid places with fairly good forest cover one is likely to find the terrestrial ecitons occupying surface bivouacs as in the rainy season. As a rule, however, it is notable that in the statary phase of their activity cycle colonies in dry areas tend to go down into subterranean retreats instead of going up (e.g., into hollow standing trees) as colonies do with great frequency in the time of rains. This may be considered a special phase of the typical eciton *altitudinal migration* upon which we have commented (Schneirla, 1945).

Beyond differences such as these, what we have found in this survey indicates that the fundamental pattern of eciton activities in the dry season is substantially that of the rainy season. Among more than 50 colonies encountered, 20 colonies of *Eciton* (*sensu stricto*) (representing four different species) were thoroughly investigated both in behavior and in internal condition, with the finding that each of them at the time of study coincided in all particulars with some definite stage of the previously described nomad-statory cycle. None but secondary variations were discovered. For instance, colonies in their nomadic phase occasionally stage definitely smaller raids than those of the rainy season, and at times no bivouac-

change movement occurs after such underdeveloped forays—a result to be expected from our general theory (Schneirla, 1938). When colonies are in the statary condition the dry-season inhibition of raiding is correspondingly more pronounced than in nomadic circumstances. Statory colonies typically exhibit more raidless days than under rainy-season conditions, the more so when in very dry and exposed situations. However, we return to the fact that in widely separated parts of southern Mexico and at very different times in the dry season the described nomad-statory cycle of events appeared to prevail among the various species of terrestrial ecitons encountered.

It is possible that this survey has not sampled adequately the entire range of eciton reactions to dry-season conditions. In certain of our areas it was difficult or impossible to find army-ant colonies, although the reports of residents indicated that the "soldadas" put in an appearance in the time of rains. It might be expected that in dry or poorly covered areas furnishing a sparse supply of booty, eciton colonies become so inhibited in their external activities that even repeated searching of the same terrain fails to disclose their presence. In the absence of direct evidence, we have suggested that under given conditions colonies may undergo prolonged desiccation and starvation even to the point of extermination. A time of particular vulnerability would seem to be the statary period, if the last nomadic moves happen to carry a colony into an area which subsequently dries out during the time when the possession of an enclosed and inactive pupal brood does not promote effective bivouac-change movements. Laboratory tests indicate that a colony in such straits could be expected to consume its brood, and although no instances of extreme brood cannibalism have been observed in the field, the possibility exists as one buffer against extermination. Another is the manner in which ecitons can shift the position of their bivouac through limited distances when subjected to non-optimal extremes of bright light or atmospheric dryness. Despite such incidental safeguards, it is quite possible that the dry

season makes fairly heavy inroads among the population of eciton colonies

From our evidence certain new inferences may be drawn concerning the reproductive capacities of the army-ant queen. Evidently the functional eciton queen is able to continue her reproductive rhythm under dry-season conditions, producing her new broods at well-separated intervals in a manner resembling her rainy-season performance. Whether her rhythmic function is maintained throughout the dry season, as it is during the rainy season, cannot be said here. However, granting the deficiencies of cross-sectional evidence, it should be emphasized that our records strongly support the possibility. Judging from the brood circumstances of their colonies, all of our queens taken at various times in the dry season were at a definite stage of the reproductive cycle when captured. Circumstantially, our findings also suggest that in the dry season the duration of the inter-ovulation periods must be fairly constant for the queens of different colonies. Were this not so, we should not expect to find the regular coincidence of broods and queen's condition which held without exception in colonies taken randomly as and where they were found.

Even more surprising is the fact that eciton queens are very prolific under seemingly adverse dry-season conditions. The broods are predominantly large, typically approaching the magnitude of rainy-season broods, and with but one exception in our cases each brood represented a graduated series of developing workers. The ability of the queens to produce broods of such proportions, and of the colonies to carry them through the period of larval development when they consume relatively great quantities of food, shows that even in dry weather the rain forest environment furnishes the very considerable quantities of booty which are essential. Were the supply of other insects and in particular their developing forms to drop greatly in the dry season, the tropical ecitons obviously could not continue to exist on the typically high metabolic and activity level of their nomadstatary pattern, since the phases of that

pattern are closely (although indirectly) balanced against food supply.

This study has added relatively little evidence on one of the most baffling questions of eciton life: the problem of when and under what circumstances the sexual forms appear. Concerning the fertile females we have only the conclusion from previous investigations that new queens do not appear during the principal part of the regular rainy season. When this study began the writer held the notion that these critically important individuals might well appear during the latter part of the dry season. The principal basis of this expectation was that after a long period of relative inanition, increased temperature, and other special dry-season conditions, certain special changes in brood production might arise provided the queen's fertility continued. In particular, very small broods might be expected, either because of the queen's lowered metabolic resources or because of brood cannibalism by starved workers, or both of these causes. If all or most of the eggs in such a reduced brood were fertilized (diploid?), on the basis of Dzierzon's theory¹ they could give rise to female individuals, either workers or queens according to conditions. The assumption is warranted at this stage that the critical determining condition is an overfeeding during larval development which would carry some individuals beyond the threshold of the worker pattern and produce queens or dichthadiigyne forms. Such overfeeding would not be expected with broods of immense size as in the regular rainy season, since under such conditions even with plentiful food all of the larvae in the bivouac are fed equivalently and on substantially the same chance basis which holds all below the queen development threshold. This hypothesis for the queen production process is based upon the premise that quantitative differences in feeding influence the development of larvae arising from genetically equivalent fertilized eggs.²

¹ Supported for bees by recent work such as Haydak's (1943) and for ants by Wesson (1940).

² The possibility of qualitatively differentiated feeding, not satisfactorily demonstrated in other social insects (Haydak, 1943), seems even more doubtful for the ecitons with their relatively crude food delivery processes.

Although no colonies with supernumerary queens were found at any time during the present study, the possibility remains that such colonies (if broods were small and extra-bivouac activities minimal) were unavoidably passed over in the search or were among those whose bivouacs eluded study. It seems probable, in any event, that queen production is a relatively brief episode in the annual life of the ecitons.

Fortunately more evidence is available for the males. From the scattered records of eciton male captures in Central and South America, it seems probable that the males appear in distinct broods of a few thousand or less individuals, and that their development characteristically occurs in the dry season. On the grounds of admittedly scanty evidence, it may be suggested further that the male brood or broods of a given colony are limited seasonal events regularly synchronized with the queen's reproductive cycle but occurring under

exceptional conditions. Synchronization of these broods in the cycle is a reasonable inference, although the cases are few, but nothing definite can be offered concerning the specific conditions of their appearance. It seems possible that somehow the fertilization of eggs is blocked altogether during a given ovulation episode. Whether this is a matter of seasonal depletion of sperm, or a temporary inhibition of the insemination process owing to special ecological circumstances (e.g., high temperature, dryness), or a reduced metabolic condition of the queen (owing, for example, to starvation; Wheeler, 1928), only further investigation can reveal. The apparent seasonal regularity and temporary nature of the unknown sterile condition evidently involved suggests that it is not simply a matter of exhausting the sperm supply but must involve a special change of more complex nature in the queen.

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NOTES ON GRINNELL'S TYPES OF *ERYNNIS* SCHRANK (LEPIDOPTERA, HESPERIIDAE)

BY CYRIL FRANKLIN DOS PASSOS

While rearranging some species of *Erynnis* Schrank (1801) in the author's collection, the proper placement of specimens representing Grinnell's names proved puzzling and led to a study of their status. That investigation eventually involved one of Dyar's names and has resulted in the following notes concerning the synonymy of the insects.

Erynnis callidus callidus (Grinnell)

Thanaos callidus GRINNELL, 1904, Ent. News, vol. 15, p. 114, figs. 1-3.

Nisoniades lacustra WRIGHT, (*partim*), 1905, The butterflies of the West Coast, p. 253, pl. 32, figs. 480, a.

Thanaos callidus, DYAR, 1905, Jour. New York Ent. Soc., vol. 13, p. 121.

Nisoniades callidus GRINNELL, 1905, Ent. News, vol. 16, p. 339.

Thanaos callidus, SKINNER, 1914, Trans. Amer. Ent. Soc., vol. 40, p. 202.

Thanaos callidus, BARNES AND McDUNNOUGH, 1916, Contributions, vol. 3, p. 122.

Thanaos callidus, McDUNNOUGH, 1917, Ent. News, vol. 28, p. 232.

Thanaos callidus, LINDSEY, 1921, Univ. Iowa Studies Nat. Hist., vol. 9, p. 52.

Thanaos callidus, SKINNER AND WILLIAMS, 1924, Trans. Amer. Ent. Soc., vol. 50, p. 195.

Erynnis callidus, COMSTOCK, 1927, Butterflies of California, p. 213, pl. 59, figs. 7-8.

Thanaos callidus, McDUNNOUGH, 1927, Canadian Ent., vol. 59, p. 162.

Thanaos callidus, HOLLAND (*nee* Grinnell), 1931, The butterfly book, revised ed., p. 350.

Erynnis callidus, LINDSEY, BELL, AND WILLIAMS, 1931, Denison Univ. Bull. Jour. Sci. Lab., vol. 26, p. 62.

Thanaos callidus, FORBES, 1936, Psyche, vol. 43, p. 104.

This insect was described from a series said to consist of four males and one "female" taken on Mount Wilson, Sierra Madre Mountains, Los Angeles County, California, at 5886 feet on June 6, 1903. The original description furnishes a figure

of the genitalia, but the most interesting clasp, i.e., the left one, is not shown. However, the right clasp agrees quite well with the author's dissection of one of the cotypes of *callidus*.

When the American Museum of Natural History purchased the Gunder collection it acquired three of the five cotypes of *callidus*, i.e., two males and one "female." One of the males was without an abdomen. It is possible that this abdomen was dissected by Grinnell in order to draw the figures for the original description. The "female" cotype is actually a male of a different species, i.e., *lacustra* Wright. A third male cotype, possibly a female *lacustra*, was sent to Dyar (1905, p. 121). This specimen does not appear to be in the United States National Museum. Although it is possible that the fourth male cotype was given to the California Academy of Sciences, it has not been found in that collection. Therefore, it must be presumed that these two specimens have been lost or destroyed. Whether or not the two missing cotypes were the same species as the ones figured by Grinnell and dissected by the present author, it is possible to fix the name definitely from the male cotype, of which a slide has been made.

The attempt of Skinner and Williams (1924, pp. 195-196) to restrict the name *callidus* to the "female," subsequently described by Wright as *lacustra*, cannot stand because Barnes and McDunnough (1916, p. 123) had already restricted the name to the male. The male in the American Museum of Natural History (genitalic slide No. 241, C. F. dos Passos), is hereby designated the lectotype of *Thanaos callidus* Grinnell, and labeled accordingly. The other male cotype thus becomes a

paratype, and will be deposited with the California Academy of Sciences. The "female" paratype remains in the American Museum of Natural History.

***Erynnis callidus pernigra* (Grinnell)**

Thanaos pernigra GRINNELL, 1905, Ent. News, vol. 16, p. 34.

Thanaos pernigra, DYAR, 1905, Jour. New York Ent. Soc., vol. 13, p. 121.

Thanaos persius var. *pernigra*, SKINNER (nec Grinnell), 1914, Trans. Amer. Ent. Soc., vol. 40, p. 207.

Thanaos pernigra, McDUNNOUGH, 1917, Ent. News, vol. 28, p. 232.

Thanaos persius race *pernigra*, LINDSEY, 1921, Univ. Iowa Studies Nat. Hist., vol. 9, p. 52.

Thanaos persius race *pernigra*, SKINNER AND WILLIAMS (nec Grinnell), 1924, Trans. Amer. Ent. Soc., vol. 50, p. 198.

Erynnis persius pernigra, COMSTOCK, 1927, Butterflies of California, p. 213, pl. 59, figs. 5-6.

Erynnis persius race *pernigra*, LINDSEY, BELL, AND WILLIAMS, 1931, Denison Univ. Bull. Jour. Sci. Lab., vol. 26, p. 61.

Thanaos pernigra, FORBES, 1936, Psyche, vol. 43, p. 104.

Erynnis persius pernigra, FREEMAN (nec Grinnell), 1943, Ent. News, vol. 54, p. 73.

This insect was described from a single male taken in Mill Valley, on the slopes of Mount Tamalpais, Marin County, California, on May 19, 1904. The pertinent parts of the original description read as follows: "Upperside: primaries entirely blackish-slate, with a very thin sprinkling of grayish hairs; three very small, white dots arranged diagonally, in the costo-apical part of the wing. Secondaries: entirely seal-brown, with long hairs along the inner margin and basal part of wing. Underside of both wings entirely Van Dyke brown; the three costo-apical white spots visible through the wing. Abdomen and thorax same color as adjacent parts of the wings. Palpi clothed with long hairs. Antennae entirely of same color as the primaries on the upperside."

This type also was received by the American Museum of Natural History when it acquired the Gunder collection. Unfortunately the genitalia were missing, the abdomen having been cut in two. Grinnell in his original description wrote that he intended to figure the genitalia, so it seems probable that he removed them from this specimen for that purpose. How-

ever, he never did figure them. Fordyce Grinnell, Jr., died on July 20, 1943, prior to which time his collection was purchased by Dr. John A. Comstock and is now in the Los Angeles County Museum. Mr. Lloyd M. Martin, Assistant Curator of Entomology of that institution, very kindly made a diligent search for this slide, but it has not been found. Neither has Gunder accounted for it. Apparently the slide, if it ever existed, has been lost or destroyed.

Fortunately a topotype of *pernigra* exists in the Barnes collection in the United States National Museum. It was taken by the same collector on the same day and at the same locality as the type. Through the courtesy of Mr. W. D. Field of the United States Department of Agriculture, it has been possible to examine this specimen and a slide of its genitalia. The specimen agrees perfectly with the type, being only slightly smaller and in better condition. The genitalia are similar to that of *callidus*, but owing to minor differences in maculation and the very different habitat in which *pernigra* occurs, the rainfall being twice as heavy as where *callidus* flies, it is deemed advisable to give the name subspecific standing for the present. Perhaps an examination of long series of topotypes of *callidus* and *pernigra* will result some day in sinking the latter name.

Various authors, commencing with Skinner, expressed the opinion that *pernigra* was a race of *Erynnis persius* (Scudder) (1863, Proc. Essex Inst., vol. 3, p. 170). Upon what evidence some of them reached this conclusion is not apparent, because they could not have examined the genitalia of the type. Mr. H. A. Freeman of Pharr, Texas, kindly lent me the specimen of "*pernigra*," together with a drawing of the genitalia thereof, upon which he reached the conclusion that *pernigra* is a subspecies of *persius*. However, the specimen, although topotypical of "*pernigra*," is in fact a western subspecies of *persius*, not *pernigra*, as is conclusively shown by the wing pattern and the drawing of its genitalia.

***Erynnis callidus lilius* (Dyar)**

Thanaos lilius DYAR, 1904, Proc. U. S. Natl. Mus., vol. 27, p. 788

Thanaos lilius DYAR, 1905, Jour. New York Ent. Soc., vol. 13, p. 121.

Thanaos lilius, SKINNER, 1914, Trans. Amer. Ent. Soc., vol. 40, p. 207.

Thanaos lilius, SKINNER AND WILLIAMS, 1924, Trans. Amer. Ent. Soc., vol. 50, pp. 196, 198.

Thanaos lilius, LINDSEY, BELL, AND WILLIAMS, 1931, Denison Univ. Bull. Jour. Sci. Lab., vol. 26, p. 62.

Thanaos lilius, FORBES, 1936, Psyche, vol. 43, p. 104.

This insect was described from two specimens taken in the Kootenai District of British Columbia.

Shortly after publishing this name, Dyar expressed doubt concerning its validity. However, an examination of the type in the United States National Museum, obligingly undertaken by Dr. C. D. Michener

and Mr. W. D. Field, and of northern Californian material in the author's collection, leads to the conclusion that the name is perfectly valid in a subspecific sense, and is applicable to the population of *callidus* occurring between northern California and British Columbia. These insects are considerably larger than *callidus* and *per-nigra* (33 mm. against 29 mm.), and are more distinctly marked on the upper side of the primaries.

As a result of this study, the foregoing names will stand in check list order as follows:

- callidus* (Grinnell)
- a. *per-nigra* (Grinnell)
- b. *lilius* (Dyar)

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SEVEN NEW SUBSPECIES OF BIRDS FROM VENEZUELA AND BRAZIL¹

BY JOHN T. ZIMMER AND WILLIAM H. PHELPS

New material in the Phelps Collection, Caracas, Venezuela, shows the new subspecies which are described in this paper.

The junior author wishes to thank the personnel of the Bird Department of the American Museum of Natural History, Mr. Rodolphe Meyer de Schauensee of the Academy of Natural Sciences of Philadelphia and Dr. Herbert Friedmann of the United States National Museum for their aid in the examination of the material in their museums.

In the lists of specimens examined, those in the Phelps and other collections are so characterized; the remaining material is in the American Museum of Natural History.

Names of colors are capitalized when direct comparison has been made with Ridgway's "Color standards and color nomenclature."

Chordeiles pusillus esmeraldae, new subspecies

TYPE: From Esmeralda, Territorio Amazonas, Venezuela; altitude 100 meters. No. 272525, American Museum of Natural History. Adult male collected October 2, 1928, by the Olalla brothers.

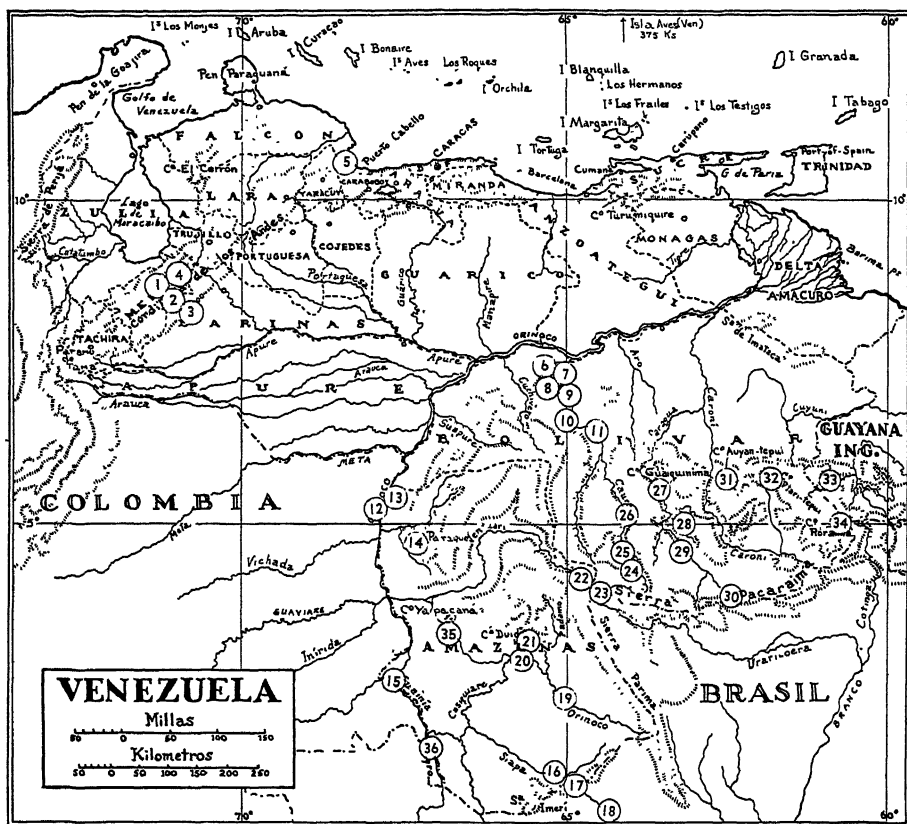
DIAGNOSIS: Differs from the other known races of *C. pusillus* by having prominently barred, instead of white, under tail-coverts. From *C. p. septentrionalis*, from farther down the Orinoco River and British Guiana, it also differs by being darker above, with more extensive black markings, and more coarsely barred below; also by being

of larger size but averaging smaller than *pusillus*.

RANGE: Known from the region of Mt. Duida, and on the Rio Negro and Rio Guainfa, Venezuela.

DESCRIPTION OF TYPE: Top of head black with small rounded marginal spots of light Auburn which become paler on the hind neck; mantle near Bister, with indistinct pale tips and marginal spots and with dusky subterminal bars; lower back with these markings more distinct and the pale spots larger and brighter rufescent; upper tail-coverts brown with broken grayish bars, more buffy distally; lores Pale Pinkish Buff; sides of head and extreme sides of throat dusky with Tawny markings. Chin narrowly dusky with light markings; a broad, pure white, V-shaped patch on anterior throat centrally, extending posteriad on sides; posterior throat blackish brown with feathers broadly edged with cinnamon; breast, abdomen, and under tail-coverts dull white prominently barred with Bister. Wings largely blackish brown, the secondaries and tertials tipped with pale cinnamon, more broadly on the inner feathers where this terminal bar is broken by a dusky shaft streak, an extension of a subterminal blackish bar; these inner feathers behind this bar are mottled with black and gray or white; outer four primaries with a white band crossing both webs on the two subexternal feathers, not reaching either margin on the fourth, and restricted to the inner web of the outermost; on the fifth there is a limited central patch merely mottled with white; all upper wing-coverts and scapulars either tipped or edged with dark or light cinnamon; bend of wing, under wing-coverts, and axillaries brown barred with buffy. Tail Clove

¹ Previous papers by the same authors, describing new birds in the Phelps Collection, are "New species and subspecies of birds from Venezuela. 1" (1944, Amer. Mus. Novitates, no. 1270), "New species and subspecies of birds from Venezuela. 2" (1945, Amer. Mus. Novitates, no. 1274) and "Twenty-three new subspecies of birds from Venezuela and Brazil" (1946, Amer. Mus. Novitates, no. 1312).



- 20 Agüita, Mt. Duida
- 34 Arabupú
- 18 Base Canoas, Río Castanho
- 21 Campamento del Medio
- 13 Caño Cataniapo
- 15 Caño Pimichín
- 20 Caño Seco
- 12 Cataracts of the Orinoco
- 3 Ciudad Bolivia, Barinas
- 6 El Cambur
- 2 El Escorial
- 7 El Llqual
- 1 El Valle (Valle)
- 28 Erebenequén, Río Carún
- 20 Esmeralda
- 8 Guayapo
- 22 Kabadisocafia
- 33 Kamarang River, British Guiana
- 30 La Candelaria
- 30 La Faisca Mine
- 9 La Prisión
- 9 La Unión
- 21 Laterite Valley
- 4 Llano Rucio
- 12 Maipures, Colombia
- 23 Mañina
- 24 Mawoña
- 31 Mt. Auyan-tepui

- 21 Mt. Duida
- 14 Mt. Paraque
- 30 Mt. Paurai-tepui
- 32 Mt. Ptari-tepui
- 34 Mt. Roraima
- 32 Mt. Sororopán-tepui
- 34 Paulo
- 21 Pico 2, Mt. Duida
- 20 Pie del Cerro
- 15 Pimichín
- 17 Poste 3, Sierra Parima
- 17 Poste 4, Sierra Parima
- 25 Río Arawa
- 27 Río Carapo
- 18 Río Castanho, Brazil
- 26 Río Chanaro (mouth)
- 10 Río Nichare
- 19 Río Ocamo (mouth)
- 16 Río Siapa
- 20 Sabana Grande
- 29 Salto María Espuma
- 11 Salto Pará
- 35 San Antonio, Amazonas
- 36 San Carlos, Amazonas
- 17 Sierra Parima
- 5 Taria, Yaracuy
- 21 Valle de los Monos

Brown, the middle rectrices with mottled grayish bars and the others barred with cinnamonous buff; terminal white spots on inner vanes of second, third, and fourth rectrices. Bill (in dried skin) black; feet brown. Wing, 128 mm.; tail, 75; exposed culmen, 4; culmen from base, 8; tarsus, 12.5.

REMARKS: Sexes alike. Intermediate in size between *C. p. pusillus* and *C. p. septentrionalis*. Range of measurements: five males (including type): wing, 126–132 (128.2) mm.; tail, 70–75 (72.4); culmen from base, 8–9 (8.5); five females: wing, 125–131.5 (128.3); tail, 67–72 (70.2); culmen from base, 7–8 (7.6). *C. p. septentrionalis*: three adult males: wing, 120–126 (123.3); tail, 63–65 (64); culmen from base, 7–8 (7.6); two adult females: wing, 122, 126; tail, 16, 67; culmen from base, 8, 8.5. *C. p. pusillus*: five adult males: wing, 130–141 (136.4); tail, 72–76 (74.2); culmen from base, 8–10 (8.8).

The amount of white on the wing is variable. In some specimens, as in the type, there is a trace of white on the fifth primary (from outside), sometimes even a small area of clear white, but in most cases the fifth feather is without white. In some cases the outer web of the outermost primary has a white spot separated from the white of the inner web by the dark shaft. In most cases the outer web is dark.

SPECIMENS EXAMINED

C. p. pusillus.—BRAZIL: Rio Theosouras, Goyaz, 1 ♂; Chapada, Matto Grosso, 4 ♀; Mutum Cavallo, 1 ♂, 1 ♀.

C. p. esmeraldae.—VENEZUELA: Valle de los Monos, foot of Mt. Duida, 1 ♂; Esmeralda, 19 ♂ (including type), 17 ♀, 1 (?) ; Sabana Grande, 1 ♀; Campamento del Medio, 1 ♂; (Phelps Collection): Pimichín, 1 ♂, 3 ♀; (U. S. National Museum): San Carlos, Rio Negro, 4 ♂, 4 ♀; San Antonio, upper Orinoco, 1 ♂.

C. p. septentrionalis.—BRITISH GUIANA: Ananai, 2 ♂, 2 ♀. COLOMBIA: Maipures, 2 ♂ (including type).

Brachygalba lugubris obscuriceps, new subspecies

TYPE: From Rio Castanho, Base Canoas, Rio Padauri, Brazil; altitude 160 meters. No. 34848, Phelps Collection,

Caracas. Adult male collected March 6, 1946, by Felix Cardona. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Differs from all the other races of *B. lugubris* by having a darker crown; also differs from all except *B. l. naumburgi* and *B. l. melanosterna* by having a darker brown back, but differs also from these in having lighter under parts—more rufescent brownish, less blackish.

RANGE: Known from the upper Rio Padauri, Rio Negro, Brazil, and the Río Ocamo, upper Orinoco, Venezuela.

DESCRIPTION OF TYPE: Top of head and neck blackish, the feathers of the crown and neck with faint rusty tips, those of the forehead with broad buffy white tips; back and rump Clove Brown; longer upper tail-coverts bluish green with metallic reflections; lores and supraocular region dusky with white spots; sides of head dusky, the feathers with chestnut shaft stripes. Chin whitish; throat, breast, and sides with light Auburn tips and blackish centers on the feathers; flanks blackish with indistinctly warmer tips to the feathers; abdomen white with a buffy wash; shanks and under tail-coverts brownish black. Remiges blackish with a faint purplish tint in certain lights and with outer margins indistinctly greenish: tertials with a greenish luster; upper wing-coverts with bluish green reflections (fresh feathers; the older, worn ones purplish); under wing-coverts blackish brown; axillaries dark brown; a white band basally across inner webs of secondaries and inner primaries. Tail metallic green on newer feathers, purplish on old ones, the outer rectrices duller. Bill (in life) "black"; feet "black"; iris "dark." Wing, 70 mm.; tail, 52; exposed culmen, 44; culmen from base, 48; tarsus, 9.

REMARKS: Sexes alike. Size similar to *B. l. lugubris*. Range of measurements: three adult males: wing, 68.5–70 (69.5) mm.; tail, 47–52 (50); culmen from base, 48; one female: wing, 72; tail, 50; culmen from base, 45.

All of the specimens, except one immature bird from Venezuela, have more or less buff on the abdomen, while only one of the Roraima series of *lugubris* has a slight indi-

cation of buffy. The two adult specimens from the Caura River have as much buff as the new race. The abdomens of *fulviventris* and *caquetae* have much more and darker buff.

SPECIMENS EXAMINED

B. l. melanosterna.—BRAZIL: Chapada, Matto Grosso, 8 ♂, 9 ♀, 4 (?); Utiarity, Matto Grosso, 1 ♂, 1 ♀; Rio Jordão, Minas Gerais, 1 ♂, 1 ♀; Fazenda Esperança, Goyaz, 4 ♂.

B. l. naumburgi.—BRAZIL: Piahy, 1 ♂, 1 ♀; Maranhão, 3 ♂, 3 ♀.

B. l. lugultrix.—BRITISH GUIANA: "Guiana," 1 ♂, 2 ♀. VENEZUELA: "Roraima," 1 (?), 1 (?) juv.; Arabupú, 1 ♂ juv., 4 ♀; Paulo, 1 ♂, 1 ♂ juv., 2 ♀; Rio Nichare, Rio Caura, 1 ♂, 1 ♂ juv., 2 ♀ juv.; La Prisión, 1 ♀.

B. l. obscuriceps.—BRAZIL (Phelps Collection): Rio Castanho, Base Canoas, Rio Padauri, Rio Negro, 1 ♂ (type), 1 (?); mouth of Rio Castanho, 1 ♂, 1 (?); Estirão, Rio Padauri, 1 (?). VENEZUELA: Mouth of the Rio Ocamo, upper Orinoco, 3 ♂, 1 ♀.

B. l. caquetae.—COLOMBIA: La Morelia, 2 ♂, 3 ♀; Florencia, 1 ♀.

B. l. fulviventris.—COLOMBIA: Buena Vista, 3 ♂; Villavicencio, 1 ♂, 2 ♀; "Bogotá," 6 (?).

Automolus rubiginosus venezuelanus, new subspecies

TYPE: From Mt. Auyan-tepui, State of Bolívar, Venezuela; altitude 460 meters. No. 323697, American Museum of Natural History. Adult female collected March 5, 1938, by W. H. Phelps, Jr., Phelps Venezuelan Expedition; original no. 2045.

DIAGNOSIS: Similar to *A. r. obscurus* of French Guiana in pattern but top of head, back, outer surface of wings and flanks distinctly less rufescent brown, more olive-tinged; belly rather lighter, less warmly colored; bill apparently heavier on average.

RANGE: Known from the Tropical Zone at the bases of Mts. Auyan-tepui and Paurai-tepui, from the upper Paragua River and the Sierra Parima, in southern Venezuela.

DESCRIPTION OF TYPE: Top and sides of head, back, and rump Brussels Brown (head a little darker); upper tail-coverts bright Auburn. Throat Auburn × Sanford's Brown, chin lighter; breast and abdomen Dresden Brown; sides, flanks, and vent Prout's Brown × Mummy Brown, under tail-coverts more rufous. Remiges

Natal Brown, the outer vanes of primaries and secondaries, and the entire tertials, Argus Brown; basal edges of inner vanes light cinnamonaceous, more extensive towards the tertials; upper wing-coverts Brussels Brown uniform with back; under wing-coverts Tawny; axillaries lighter. Tail above, Chestnut-Brown × Carob Brown; below, bright Auburn. Bill (in life) "horn"; feet "olive green"; iris "brown." Wing, 80 mm.; tail, 66.5; exposed culmen, 20; culmen from base, 24; tarsus, 24.

REMARKS: Sexes alike in coloration; female slightly smaller. Range of measurements: three adult males: wing, 84–88 (86) mm.; tail, 72–74 (73); culmen from base, 24–24.5 (24.2); five adult females: wing, 79–82 (80); tail, 66.5–74 (69.6); culmen from base, 23–24 (23.7). *T. c. obscurus*: one female: wing, 77; tail, 69; culmen from base, 23.

SPECIMENS EXAMINED

A. r. rubiginosus.—MEXICO: Jalapa, 1 ♂.

A. r. veraepacis.—GUATEMALA: Finca Sepacuite, 4 ♂, 1 ♀; La Perla, 1 ♂; "Guatemala," 1 (?).

A. r. umbrinus.—GUATEMALA: "Guatemala," 1 (?). NICARAGUA: San Rafael del Norte, 1 ♂.

A. r. fumosus.—PANAMÁ: Chiriquí, 1 ♂, 2 ♀, 1 (?).

A. r. saturatus.—PANAMÁ: Tacarcuna, 1 ♀. COLOMBIA: Alto Bonito, Antioquia, 1 ♂.

A. r. rufipictus.—COLOMBIA: Chirua, 1 ♂.

A. r. cinnamonomeigula.—COLOMBIA: La Morelia, 1 ♂, 2 ♀.

A. r. brunnescens.—ECUADOR: Río Suno, above Avila, 1 ♂; below San José, 1 ♀.

A. r. nigricauda.—ECUADOR: Río Sipayo, 1 ♂; Paramba, 1 ♂; Río de Oro, 1 ♂; Bucay, 1 ♀; Santa Rosa, 1 ♂.

A. r. venezuelanus.—VENEZUELA: Mt. Auyan-tepui, 1 ♀ (type). (Phelps Collection): La Fraïsa Mine, Mt. Paurai-tepui, 2 ♂, 3 ♀; La Candelaria, Mt. Paurai-tepui, 1 ♀; Erebenquén, Río Carún, 1 (?); Sierra Parima, sources of Río Siapa and Río Padauri (Brazilian), 1 ♂.

A. r. obscurus.—FRENCH GUIANA: Approuage River, 1 ♀.

Schistocichla caurensis australis, new subspecies

TYPE: From Pie del Cerro, Mt. Duida, Territorio Amazonas, Venezuela; altitude 225 meters. No. 273932, American Museum of Natural History. Adult female collected March 8, 1929, by the Olalla brothers.

DIAGNOSIS: Similar to *S. c. caurensis* from the Caura and Paragua rivers, Venezuela, but females with the back and under parts paler than in the typical form; males with the back blacker, without a brownish tinge.

RANGE: Known from the Tropical Zone at the cataracts of the Orinoco, Mt. Paraque, the foot of Mt. Duida, and the Sierra Parima.

DESCRIPTION OF TYPE: Top of head largely Sepia, the feathers edged with dusky giving a scalloped appearance; forehead and sides of head gray; back and rump Brussels Brown $\times$ Argus Brown; upper tail coverts dusky olive. Point of chin grayish; throat, breast, and abdomen Amber Brown $\times$ Sanford's Brown; flanks, crissum, and under tail-coverts dark Prout's Brown. Wings Natal Brown; remiges edged with Prout's Brown, including exposed areas of the tertials; a prominent triangular spot of Orange-Cinnamon on the tips of all upper wing-coverts except the primary ones (and a very small one on the tips of the longer tertials); bend of wing Pinkish-Cinnamon; under wing-coverts grayish, tipped with buff; axillaries light Prout's Brown. Tail Fuscous-Black, with outer margins like the upper tail-coverts. Maxilla (in dried skin) black; mandible grayish, dark at tip; feet dark brown. Wing, 80 mm.; tail, 74; exposed culmen, 22; culmen from base, 25; tarsus, 30.

REMARKS: Sexes different. Size similar to *S. c. caurensis*. Range of measurements: five males: wing, 84-87 (85); tail, 72-80 (76); culmen from base, 25.5-26.5 (26); five females: wing, 80-86 (83.4); tail, 74-76 (75); culmen from base, 24-26 (24.6).

DESCRIPTION OF MALE: Above Dark Neutral Gray, more dusky on rump and upper tail-coverts; top of head a little lighter gray, with narrow blackish terminal margins on the feathers, giving a scalloped appearance; sides of head grayish slate uniform with under parts. Below Deep Neutral Gray $\times$ Slate Color. Remiges Fuscous-Black with slightly lighter outer margins; upper wing-coverts black with small white terminal spots. Tail blackish. Bill (in dried skin) black; feet black.

SPECIMENS EXAMINED

S. c. caurensis.—VENEZUELA: El Llagual, lower Caura River, 2 ♂ (including type), 1 ♀; "Caura Valley," 1 ♀; mouth of Río Chanaro, upper Caura, 1 ♂; (Phelps Collection): Salto Pará, 2 ♂, 2 ♀; Río Carapo, Río Paragua, 1 ♀; Salto María Espuma, 1 ♂.

S. c. australis.—VENEZUELA: Valle de los Monos, Mt. Duida, 2 ♀; Caño Seco, 2 ♂, 1 ♀; Pie del Cerro, 1 ♀ (type); (Phelps Collection): Caño Cataniapo, 2 ♂; Mt. Paraque, 3 ♂, 3 ♀; Sierra Parima, boundary, post 3, 1 ♀; post 4, 1 ♂.

Ramphotrigon megacephala pectoralis, new subspecies

TYPE: From Sierra Parima, headwaters of Río Siapa, Territorio Amazonas, Venezuela; altitude 540 meters. No. 34995, Phelps Collection, Caracas. Adult female collected March 22, 1946, by Félix Cardona. (Type on deposit at the American Museum of Natural History.)

DIAGNOSIS: Most similar to *R. m. boliviana* of Bolivia and *R. m. venezuelensis* of northern Venezuela but bill larger, wings and tail darker brown, under parts more deeply colored, with breast notably darker and the pectoral stripes more prominent; green of back clearer; top of head more strongly green, with dusky shaft marks equally prominent.

RANGE: Known only from the Tropical Zone of the Sierra Parima near the Brazilian frontier.

DESCRIPTION OF TYPE: Top of head Olive-Green, feathers with dusky markings on shafts; back and rump Serpentine Green $\times$ Roman Green, upper tail-coverts paler; lores dusky; superciliary stripe and lower eyelid buffy; ear-coverts and cheeks buffy with dusky olivaceous tips. Throat Amber Yellow, striped with dusky olivaceous, breast most strongly so with a slight buffy tinge; sides dark Buff Olive; belly clear Straw Yellow; shanks olivaceous, under tail-coverts paler. Wings Fuscous-Black; primaries edged with dark olivaceous, secondaries and tertials with outer margins broader and more buffy; greater and median wing-coverts broadly tipped with deep buff forming two pronounced bands; lesser coverts tipped with the color of the back; under wing-coverts Straw Yellow, bend of wing more orange; axillaries more

buffy; inner margins of remiges Ivory Yellow. Tail Fuscous-Black; rectrices edged externally with olivaceous and very faintly and narrowly tipped with dull buff. Bill (in life) "black"; feet "gray"; iris "dark." Wing, 60 mm.; tail, 50; exposed culmen, 12; culmen from base, 16; tarsus, 16.

REMARKS: Size similar to *R. m. bolivi-ana*. This rare species has a very interrupted range as far as known: *megacephala* in southern Brazil, Paraguay, and Argentina; *boliviana* in Bolivia; *venezuelensis* from one locality on the northern edge of the Apure Valley in northern Venezuela and from the north coast from one specimen only. Now a single specimen of this new form has been taken near the Venezuelan-Brazilian frontier.

SPECIMENS EXAMINED

R. m. megacephala.—ARGENTINA: Puerto Segundo, 1 (?).

R. m. boliviana.—BOLIVIA: Mission San Antonio, Río Chimoré, Cochabamba, 2 ♂ (including type), 1 ♀.

R. m. pectoralis.—VENEZUELA (Phelps Collection): headwaters of Río Siapa, Territorio Amazonas, 1 ♀ (type).

R. m. venezuelensis.—VENEZUELA (Phelps Collection): Ciudad Bolivia, Barinas, 3 ♂; Taria, Yaracuy, 1 (?).

Orochelidon murina meridensis, new subspecies

TYPE: From Llano Rucio, State of Mérida, Venezuela; altitude 2500 meters. No. 14256, Phelps Collection, Caracas. Adult male collected September 8, 1941, by Ramón Urbano. (Type on deposit at American Museum of Natural History.)

DIAGNOSIS: Differs from *O. m. murina* of Colombia, Ecuador, and Perú by having paler, more grayish brown under parts and more whitish throat; upper parts averaging more bluish, less greenish.

RANGE: Known only from the upper Subtropical Zone of the Andes of Mérida, at altitudes above 2200 meters.

DESCRIPTION OF TYPE: Top of head, back, and uropygium shining Green-Blue Slate × Dark Green-Blue Slate with subterminal portion of feathers brownish; sides of head brownish black, darker on lores, with slight bluish reflections on ear-

coverts. Chin dull whitish, merging into the dull Drab-Gray of the breast, and darkening to light Mouse Gray on the abdomen and sides; under tail-coverts dark brown broadly tipped with lustrous bluish preceded by a narrow black subterminal bar. Upper surface of wings dark Chaetura Drab (black on fresher feathers); under surface of remiges, bend of wing, under wing-coverts, and axillaries uniform with breast but with some whitish markings on the bend of the wing. Tail dark Chaetura Drab, paler on under surface. Bill (in life) "black"; feet "brown"; iris "dark." Wing, 110 mm.; tail, 62; exposed culmen, 6; culmen from base, 8; tarsus, 11.

REMARKS: Sexes alike. Size similar to *O. m. murina*. Range of measurements: five adult males: wing, 110–119 (114.2) mm.; tail, 58.5–69 (62.4); culmen from base, 8–9 (8.5); one adult female: wing, 110; tail, 61; culmen from base, 8. *O. m. murina*: five adult males: wing, 114–122 (117.6); tail, 61–68 (64); culmen from base, 8–9 (8.5).

The upper parts are darker and more bluish, less greenish than the great majority of *murina*, but an occasional specimen of the typical form agrees with *meridensis* in this respect.

This new swallow has escaped the intensive commercial collecting in the Mérida region by Briceño Gabaldón during nearly 80 years, undoubtedly because of the difficulty in collecting such a fast and high-flying bird at such high altitudes.

SPECIMENS EXAMINED

O. m. cyanodorsalis.—BOLIVIA (Academy of Natural Sciences of Philadelphia): Hichuloma, La Paz, 3 ♂ (incl. type), 3 ♀.

O. m. murina.—ECUADOR: Cayambe, 1 ♂, 1 ♀; Valle de Cumbaya, 1 ♂, 1 ♀; Río Oyacachi, below Chaco, 2 ♀; El Corazón, 1 ♂, 1 ♀; Quito, 1 ♀; Mt. Chimborazo, 2 ♂; Nanegal, 1 ♂; Mt. Pichincha, 2 ♂, 1 ♀.

O. m. meridensis.—VENEZUELA (Phelps Collection): Llano Rucio (2500 meters), 2 ♂ (including type); El Valle (2200 meters), 4 ♂, 1 ♀. El Escorial, (2800 meters), 1 ♂.

Thryothorus coraya obscurus, new subspecies

TYPE: From Mt. Auyan-tepui, State of Bolívar, Venezuela; altitude 1100 meters.

No. 324826, American Museum of Natural History. Adult male collected February 19, 1938, by E. Thomas Gilliard, Phelps Venezuelian Expedition; original no. 1640.

DIAGNOSIS: Similar to *T. c. ridgwayi* from British Guiana and Mt. Roraima, but upper parts deeper rufous; lower under parts browner, less rufescent.

RANGE: Known only from the Subtropical Zone of Mt. Auyan-tepui, at altitudes of 1100 and 1800 meters.

DESCRIPTION OF TYPE: Crown Mummy Brown, forehead more dusky; nape Prout's Brown; back light Chestnut, paler on rump and upper tail-coverts, the latter with very faint dusky bars; lores, sides of head, and throat black; a prominent white superciliary stripe, not reaching lores; lower eyelid medially white; shafts of auriculars white. Chin, middle of throat, and upper breast white; lower breast and middle of abdomen Cinnamon-Buff becoming Brussels Brown × Cinnamon Brown on sides and flanks; under tail-coverts barred with black. Remiges Fuscous; primaries and secondaries narrowly edged with reddish brown and the tertials broadly with chestnut; wing-coverts edged with chestnut uniform with back; under wing-coverts and axillaries grayish. Tail black, the median and outer pairs and the outer webs and tips of the others barred with Buffy Brown above, Light Drab below. Maxilla (in life) "black"; mandible "blue gray, tip black"; feet "dark gray"; iris "brown." Wing, 60 mm.; tail, 54; exposed culmen, 16; culmen from base, 18; tarsus, 23.

REMARKS: Sexes alike in color. Size quite similar to *T. c. ridgwayi* but very slightly larger on average. Range of meas-

urements: four adult males: wing, 59-62 (60.6) mm.; tail, 52-57 (55); culmen from base, 18-19 (18.5); two adult females: wing, 55, 55 (55); tail, 50, 55 (52.5); culmen from base, 18, 18 (18). Four adult males of *ridgwayi*: wing, 57-60 (58.7); tail, 50-56 (54.2); culmen from base, 16.5-18 (17.1).

The series from Mt. Ptari-tepui averages lighter below than that from Mt. Roraima.

SPECIMENS EXAMINED

T. c. coraya.—FRENCH GUIANA: Pied Saut, 2 ♂, 1 ♀; Ipousin, 1 ♂; Approuague, 3 ♂, 1 ♀; Tamanoir, 1 ♂; "Cayenne," 1 (?). DUTCH GUIANA: "Surinam," 2 (?); Paramaribo, 2 (?). BRITISH GUIANA: Rockstone, 3 ♂, 1 ♀, 1 (?); Wismar, 1 ♀. BRAZIL: Faro, 1 ♂; Obidos, 1 ♀.

T. c. ridgwayi.—BRITISH GUIANA: Kamarang River, 1 ♂, 1 ♀ juv. VENEZUELA: "Mt. Roraima," 1 ♂, 3 ♀; Paulo, 2 ♂, 1 ♀; Arabupú, 1 ♂; (Phelps Collection): Arabupú, 7 ♂; Mt. Ptari-tepui (1350-2000 meters), 4 ♂, 3 ♀, 1 (?); Mt. Sororopán-tepui, 2 (?).

T. c. obscurus.—VENEZUELA: Mt. Auyan-tepui (1100 and 1800-2000 meters), 4 ♂ (including type), 2 ♀, 1 (?); (Phelps Collection): Mt. Auyan-tepui (1100 meters), 1 ♂, 1 (?).

T. c. caurensis.—VENEZUELA: Río Nichare, Río Caura, 1 ♀; La Unión, 3 ♂; La Prisión, 1 ♀, 1 (?); (Phelps Collection): Salto Pará, Río Caura, 4 ♂, 2 ♀; Kabadisocaña, 1 (?); Mañina, 1 ♀; Mawoña, 1 ♀; Río Arawa, 1 ♀, 1(?); Guayapo, 1 ♂, 1 ♀; El Cambur, 1 ♂, 1 ♀.

T. c. herberti.—BRAZIL: Cameté, Rio Tocantins, 1 ♂, 1 ♀; Santarem, 2 ♀.

T. c. amazonicus.—PERÚ: Lagarto, Alto Ucayali, 1 ♂; Santa Rosa, 1 ♀.

T. c. cantator.—PERÚ: Tulumayo, Junín, 1 ♂, 1 ♀.

T. c. griseipectus.—PERÚ: Nauta, 3 ♂, 1 ♀, 2 (?); mouth of Río Curaray, 4 ♂, 3 ♀. ECUADOR: mouth of Lagarto Cocha, 1 ♀; lower Río Suno, 3 ♂, 2 ♀; below San José, 1 ♂, 5 ♀; Archidona, 1 ♀; Catapino, 1 ♂.

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A NEW FRINGE-FOOTED SAND LIZARD FROM COAHUILA, MEXICO

BY KARL P. SCHMIDT AND CHARLES M. BOGERT

The Parras Basin in southern Coahuila has not been well explored herpetologically despite the fact that it is readily accessible from the highway that traverses the region from Saltillo to Torreon. Partly because the region has been neglected, it was chosen as a suitable place in which to carry out field work during the summer of 1946. In August field parties from the Chicago Natural History Museum and the American Museum of Natural History encountered an area of low dunes along the northern edge of the dry lake shown on recent maps as Laguna de Mayrán (and on older maps as the Laguna del Muerto). A lizard taken in these dunes represents not only a new species, but also the first record for the genus *Uma* from the eastern side of the Continental Divide.

Heifetz (1941, p. 99) has recently reviewed the lizards of the genus *Uma* and mapped the range of the four populations known from southern California and the adjacent portions of Baja California, Arizona, and Sonora. The easternmost record was Tepoca Bay on the west coast of Sonora, over 600 miles to the northwest of the Parras Basin. Because of the isolated position of the population discovered in the dunes near Laguna de Mayrán we are calling it

Uma exsul, new species

TYPE: No. 67404 in the collection of the American Museum of Natural History, collected by Karl P. Schmidt and C. M. Bogert, in dunes located 12 miles north of San Pedro de Las Colonias, Coahuila, Mexico, on August 20, 1946. Thirty-one paratypes taken at the same time, at the same locality, are available.

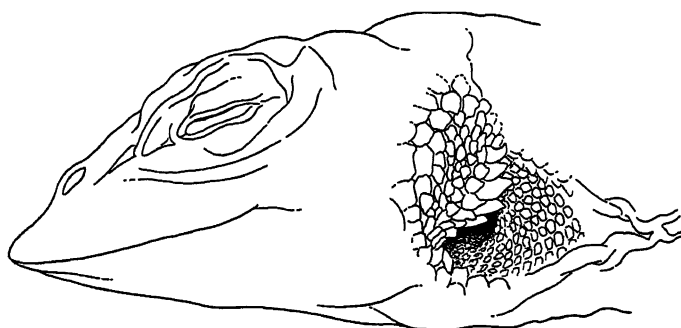
DIAGNOSIS: A *Uma* that differs from other members of the genus in lacking small subdigital scales intercalated between the fringe and the lamellae, in having two strongly enlarged auricular lobules instead of four (fig. 1), and usually four internasals in contrast to three or five in other species. In pattern characters the *Uma* from Coahuila is strikingly different from previously known forms, all of which have an ocellated pattern; reticulating black lines, emphasized at intervals to form diagonal lines or chevrons when viewed from above, enclose lighter-colored areas that may be round or elongate, without a dark spot in the center. The pattern, unlike that of other species in the genus, includes a prominent black spot on the shoulder, a diagonal lateroventral blotch at midbody that is confluent above with one of the chevrons, and two vertical black bars at the groin, with a vestige of a third on the base of the femur.

DESCRIPTION OF THE TYPE: An adult male, with the habitus approximating that of other lizards in the genus. The body and tail are flattened, the depth being about half the width. The frontal portion of the head is rounded in profile. The ear openings are vertically elliptical but hidden at the upper extremities by the auricular lobules. The adpressed front limbs extend to the groin, and the fourth toe extends slightly beyond the tip of the snout when the hind limbs are adpressed to the body.

The rostral is pentagonal and extends back on the snout to a blunt point. There are three transverse rows of internasal scales, each comprising four scales separating the nares, which are elliptical and dorsal in position. There are two enlarged canthals on each side separated by 17 scales across the head. The scales in the pre-

frontal region are enlarged more than twice the diameter of the adjacent lateral head scales. The prefrontal series of scales diminish in width posteriorly where they are confluent with two rows of less strongly enlarged scales in the frontal region. The supraoculars are feebly enlarged, and the

labials with diagonal keels, followed posteriorly by smaller, irregular scales bordering the mouth. A single row of small scales separates the supralabials from a greatly enlarged, keeled subocular. The latter is preceded by two preoculars similarly keeled. In the loreal region small scales



UMA NOTATA COWLESI

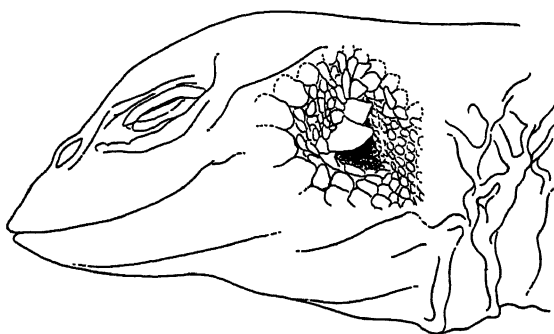


FIG. 1

UMA EXSUL

Fig. 1. Profiles of *Uma notata cowlesi* (A.M.N.H. No. 67603, from Punta Peñasco, Sonora) and *Uma exsul* (A.M.N.H. No. 67406, paratype from type locality), showing the more depressed head characteristic of lizards in the *notata* group, and the less perfectly adapted *exsul* with a profile more like that of lizards in the genus *Callisaurus*. Details show the differences between the auricular lobules of the two species.

supraorbital semicircles are ill defined. The interparietal, nearly round, with irregular edges, is the largest scale on the top of the head; in this scale, the central translucent portion that covers the parietal organ is raised as a conspicuous tubercle.

On the sides of the head there are six (right) and seven (left) enlarged supra-

are irregularly disposed; eight can be counted between the supralabials and the apex of the region delineated by the canthal and the preoculars. The ciliaries are pectinate and increase in size at each end of the series; on the lower lid the ciliaries are somewhat larger than they are on the upper eyelid. There are two greatly enlarged auricular lobules on each side, with smaller

but distinctly enlarged lobules present above and below the larger ones.

A small pentagonal mental is bordered by the first in each series of 10 smooth infra-labials on each side. The postmental is somewhat triangular, and its apex extends between the first pair of chin shields, separating them for approximately half their length. These chin shields are nearly as wide as they are long. Posteriorly there are four rows of sublabials. Small, smooth, flat scales on the gular region are slightly enlarged at the midline. A well-defined gular fold, preceded by enlarged scales, is present on the neck.

Smooth, flat scales on the under side of the body are about half the diameter of the small, slightly convex scales covering the dorsum and sides. On the pectoral region the scales are enlarged, pointed, and projecting. On the sides of the belly at mid-body the transition from large ventral scales to small lateroventrals is abrupt. Posteriorly the ventral scales diminish in size at the level of the groin but are enlarged in the pre-anal region. The scales on the under side of the base of the tail are relatively small, flat, and arranged in irregular fashion, but distally on the tail they increase in size, and rows, or whorls, are readily distinguishable. There are two enlarged, horizontally elongate postanal scales flanking a smaller median one; the posterior margins of these three scales are in contact with 10 additional less strongly enlarged scales.

The dorsum from the occiput to the base of the tail is covered with small, smooth, slightly convex scales that are nearly uniform in size. Distally on the upper surface of the tail the scales are somewhat larger, and in definite rows continuous with the series beneath the tail. The scales on the upper surface of the femur are similar to the dorsal body scales. Enlarged scales are present on the anterior surface of both front and hind limbs. The minute femoral pores, 26 on each side in widely separated series, are located at the rear extremity of enlarged, roundish scales. An area of elongate, nearly granular scales separates the femoral pore series from a patch of larger scales with projecting points located

on the proximal posterior surface of the thigh.

The infratarsals are much smaller than the supratarsals and sharply delineated from subdigital lamellae with two or three keels near the base of the digits, whereas only one keel is present on the lamellae beneath the distal portion. Fringe spines, most strongly developed along the outer edges of the toes, extend from the edges of the subdigital lamellae; there is no regular series of small subdigital scales separating the fringe from the lamellae except for isolated small scales at the digital joints. The fringe spines, counted on the external side of the fourth toe from the claw to the base of the toe as far as the spines are distinctly enlarged, number 37 on the right and 33 on the left.

The principal dimensions of the type, in millimeters, are as follows: Body length, snout to vent, 78; head length, 20; head width, 12.8; rostral to edge of interparietal, 12.5; rostral to lower anterior border of ear opening, 10.9; width of orbit, 3.7; arm fully extended, measured from the axilla to end of fourth toe, 39; leg fully extended, measured from the groin to the end of the fourth toe, 70; tail, 103, width of tail at base, 12.2.

The top and sides of the head are mottled with gray blotches, most prominent on the supralabials and the rostral. Five black crescents, none of them well defined at the apex, are present on the throat, the middle one somewhat darker than the others and continued across the labials onto the subocular. The iris, and the inner margins of the inner row of both the upper and the lower ciliaries, are black. In life the small scales above the eye were vermilion, but in the preserved specimen they are whitish, with darker mottling. The under side of the belly is immaculate white, except for the wedge-shaped lower extremity of the ventrolateral black blotch. Five black cross bars, increasingly longer distally, are present on the under side of the tail. A slit made in the belly discloses a black peritoneum.

Where the edges of the gular fold extend onto the sides of the shoulders a prominent black blotch margined with white is present

on each side. On the dorsum a complex, roughly symmetrical arrangement of black blotches, or stripes interposed with whitish dots, produces the effect of three rows of black dots, the median one down the center of the back, flanked by one on each side with larger diagonal lines extending onto the sides. Viewed from above the diagonal lines form chevrons, each with three small dark blotches (the horizontal rows comprising the interrupted rows of lengthwise lines) at the apex. Approximately nine or 10 chevrons are discernible, the posterior two terminating in conspicuous black blotches in the groin, with vestiges of a third blotch situated farther out on the femur. A dark bar with light margins is present on the posterior of the femur. In life the grayish ground color of the dorsum had a yellowish tinge.

NOTES ON THE PARATYPES: The 31 specimens¹ comprising the paratypic series were all taken within a radius of half a mile. There is little difference between sexes, although males exceed females in size. The largest and the smallest specimens in the series have incomplete tails, but those with complete or unregenerated tails range in total length from 120 mm. to a maximum of 186 mm. Snout to vent measurements for the entire sample range from 32 mm. in a juvenile to 90 mm. in an adult male. The ratio of tail to total length varies from 0.54 to 0.59 with a mean of 0.56; ratio of tail to snout-vent length from 1.18 to 1.52, mean 1.29. The ratio of the hind leg (measured from the groin to the end of the claw on the fourth toe) to the snout-vent length ranges from 0.80 to 0.98, with a mean of 0.88. The femoral pores vary in number from 19 to 28, averaging 24.8.

Four scales in the longest internasal row are normally present (21 out of 27), less commonly three, five in one specimen. The fringe spines on the outer edge of the fourth toe vary from 31 to 40, with means of 38.2 for the right side and 35.8 for the left. There is some variation in the enlarged auricular lobules; two in the middle of the series are usually considerably larger

than the others, but on one specimen three are enlarged on both sides. The postanal plates vary in size, shape, and number, tending to be relatively larger in males than in females. Consequently the sexes are difficult to distinguish without dissection.

The complexities of the pattern make it impossible to describe many of the variations in quantitative terms, but it can be stated that the number of black bars under the tail is usually six, although sometimes there are four, five, seven, or even eight. The black chevrons of adults are rudimentary on small specimens, and they are not always symmetrical; a dark diagonal line on one side of the midline may have no counterpart on the other. The black blotches on the shoulder, the sides, and the groin are invariably present on both adults and juveniles. Black gular crescents may be well defined, but they are always faint at midline, and in a few specimens they are reduced to mere traces, the throat being almost immaculate. Except on the smallest specimens, a dark horizontal bar present on the posterior surface of the femur is separated from the mottled gray dorsal color by a light stripe of approximately the same width. Vermilion shading around the eyes was observed only on adults, and the color quickly disappeared in alcohol.

RELATIONSHIPS AND COMPARISONS: As might be expected on zoogeographical grounds, *Uma exsul* differs from other species in the genus in more respects than *scoparia*, *inornata*, or *notata* (including the subspecies *cowlesi*) differ from one another. Comparisons are summarized in table 1, but it may be added that the mean number of femoral pores in *exsul* is approximately that reported for *U. n. notata*, and the mean for the fringe spines on the fourth toe is approximately that reported for *scoparia* (by Heifetz, 1941). Four internasals, predominantly present in *exsul*, occur most often in *U. n. cowlesi* (25 per cent of the specimens) and in *scoparia* (19.2 per cent). The maximum size of *exsul*, 90 mm. snout to vent, is exceeded by the other forms. Thus, there are no grounds for stating that *exsul* is more closely related to one species than to another; pattern characters indicate a totally different line of evolution, and

¹ Chicago Natural History Museum Nos. 44301-44314, and American Museum of Natural History Nos. 67405-67421.

the proportionately long legs, as well as other characters, indicate affinities with the genus *Callisaurus*.

In fact, it may be observed that some of the characters formerly used to separate *Uma* and *Callisaurus* are no longer valid. The absence of small infradigital scales separating the lamellae from the fringe spines on the toes of *exsul* (except at the joints) is also characteristic of *Callisaurus draconoides crinitus*; such scales are uniformly present and form a continuous series

other *Uma*. The black bar on the posterior surface of the femur of *exsul* occurs in virtually all specimens of *Callisaurus*, but is unknown on other species of *Uma*. The lateroventral blotch, confluent with dorsal markings on *exsul*, more closely approaches the condition found in *Callisaurus* than that in other members of the genus *Uma*. Other features of the pattern of the Coahuilan *Uma* are either unique or as much like those of either genus.

On the other hand the (1) enlarged auricu-

TABLE 1

<i>Uma notata</i> GROUP	<i>Uma exsul</i>	<i>Callisaurus</i>
1. 4 moderately enlarged auricular lobules	2 strongly enlarged auricular lobules	No enlarged auricular lobules
2. Usually 3 or 5 internasals	Usually 4, rarely 3 or 5 internasals	2, 3, or 4 internasals
3. Subdigital scales separating lamellae from fringe spines on toes	No subdigital scales separating lamellae from fringe spines on toes	No subdigital scales separating lamellae from fringe, when fringe scales are present
4. A patch of enlarged scales with projecting points on rear of femur	A patch of enlarged scales with projecting points on rear of femur	No patch of enlarged scales on rear of femur
5. Dorsal pattern of well-defined ocelli, no black bar on rear of femur, a single black, square, lateroventral blotch on both sexes (absent on one species), black gular crescents well defined or nearly absent	Dorsal pattern with 3 median rows of spots, and black chevrons, with reticulum outlining whitish dots or blotches, a black bar on rear of femur, a single black, diagonally elongate, ventrolateral blotch on both sexes, black gular crescents not well defined or nearly absent	Dorsal pattern various, some subspecies with whitish dots, a black bar on rear of femur, 3 or 2 black, diagonally elongate, black blotches (absent on females), peripheral traces of black gular crescents on some subspecies, or throat immaculate, sometimes with median bluish region
6. Femoral pores usually more than 20	Femoral pores usually more than 20	Femoral pores usually fewer than 20
7. Tail comprising approximately half the body length	Tail comprising more than half the body length	Tail usually comprising more than half the body length
8. Hind leg varying from 0.66 to 0.84 of body length	Hind leg varying from 0.80 to 0.98 of body length	Hind leg varying from 0.78 to 1.04 of body length

in the previously known species of *Uma*. The hind leg of *Uma exsul* is proportionately longer than that of other species in the genus (with a mean length approximating 89 per cent of the body length, in contrast to other species in the genus with means varying from 76 to 78 per cent), but well within the range of means (86 to 96 per cent) reported by Schmidt (1922, p. 651) for various species and subspecies of *Callisaurus*. The pattern of *Uma exsul* is unlike that of any species previously known in either genus, but it resembles some subspecies of *Callisaurus* more than it does any

lar lobules; (2) patch of enlarged scales with projecting points (more pronounced in *exsul* than in other species) on the posterior of the femur; (3) high number of femoral pores; (4) flattened body, with the width averaging twice the depth; and (5) vermilion shading around the eyes of adults, are all characters of *Uma* that are not shared with *Callisaurus*. None of the other more variable or less tangible characters—the profile, the extent of the flaring of the lips, the close fitting jaw, the granular scalation of the dorsum, the modifications in the nasal passages—offers any defi-

nite basis for referring *exsul* to one genus or the other. On the whole *Uma exsul* appears to represent a more primitive species than others in the genus. Indeed it is not difficult to imagine that *exsul* evolved from an ancestral stock that was not unlike *Callisaurus draconoides crinitus* of central Baja California, although the similarities of the two species indubitably result from parallel modifications rather than close genetic affinities. *Uma exsul* conceivably

speaking, and perhaps represent the region of origin as well as the center of dispersal for the genus. Other dunes of suitably fine aeolian sand (*vide* Stebbins, 1944) must have existed in the intervening area to permit representatives of the group to cross the Continental Divide. If such dunes are still in existence in the smaller basins to the north and to the south of the Parras Basin it is quite probable that near relatives of *exsul* will be discovered.

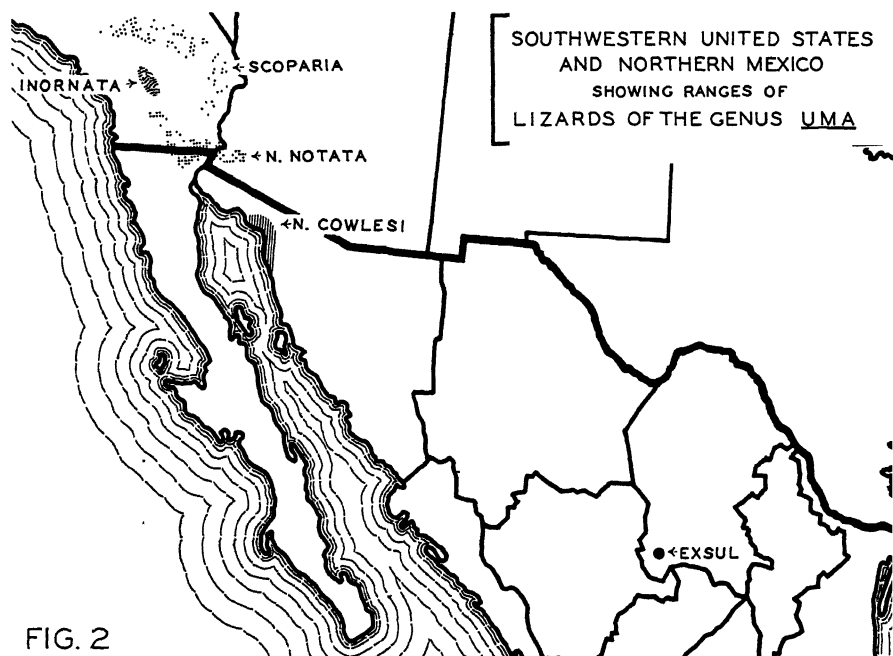


FIG. 2

represents a less progressive offshoot of the early *Uma* stock that also gave rise to the more perfectly adapted *Uma notata* and its close relatives. There can be little doubt that *exsul* was geographically isolated (see map, fig. 2) long before peripheral populations on the Mojave Desert (*scoparia*), in Coachella Valley north of Salton Sea (*inornata*), and along the west coast of Sonora (*cowlesi*) were separated from the parent stock (*notata*). The vast aeolian deposits near the mouth of the Colorado River must have been in continuous existence over a long span of time, geologically

The acquisition of the enlarged digital fringe by *Callisaurus draconoides crinitus* presumably was antedated by the same development in *Uma*. The same sort of modification has long been known for lizards inhabiting dune sand in other parts of the world. Hence it is a relatively safe assumption that fringe scales on the digits represent an adaptive response to a specialized environment, and it is less astonishing to have such fringe evolving twice in lizards descended from a common ancestral stock than it is to find such modifications on the feet of such distantly re-

lated forms as *Ptenopus* (Gekkonidae) or *Aporosaura* (Lacertidae).

HABITAT AND HABITS: The dunes along the northern edge of the dry lake, Laguna de Mayrán, where the type and paratypes were taken, are relatively low, and composed of fine gray sand. They are not lacking in vegetation. Small mesquite shrubs (*Prosopis chilensis*) on the summits of the dunes provide cover for the lizards and presumably prevent extensive shifting of the dunes. At the time the lizards were collected it was impossible to say from which side the wind had been blowing, and there was no evidence of any pronounced sand movement. The main axis of the dune ridges is approximately east and west, and whereas they are irregular, with scattered outlying hillocks, the dune area is no more than one-quarter of a mile in width. The extent of the dunes along the main axis was not ascertained, but undoubtedly encompasses a few miles.

Uma exsul was not observed outside the dune area. Both *Cnemidophorus tessellatus* and *Uta stansburiana* were taken with the *Uma*, but *Holbrookia dickersonae*, a species seen in the flats to the north, was not encountered in the dunes. The fringe-footed lizard was predominantly more abundant than either *Cnemidophorus* or *Uta*; within an hour and a half, 32 specimens were taken by two collectors with guns, using dust shot, although assistance in flushing the lizards from cover was provided by six additional members of the party.

Cloacal temperatures of 10 specimens taken between the hours of 11:15 to 11:43 A.M. varied from 36.5° C. to 41.1, with a mean of 38.8° C. It is of interest to

note that precisely the same mean was obtained by Cowles and Bogert (1944, p. 281) who recorded the body temperatures of a series of *Uma n. notata* in the dunes near Yuma, Arizona.

The behavior of *Uma exsul* under field conditions is much like that of other species, although in no instance was one observed to bury itself in the sand. More often the lizards fled into the mesquite at the summit of the dunes, sometimes emerging from the other side. When frightened they ran with great rapidity across the open sand between individual dunes to seek shelter in a more distant patch of mesquite. Two specimens were observed within a yard of each other, with backs arched and tails curled upward in some sort of display that may have been courting behavior, or one male may have been intimidating an intruder. Because the sex cannot be ascertained with certainty without dissecting, it is doubtful whether one or both sexes were involved. Females with snout-vent measurements of 67, 65, and 66 mm. contained, respectively, two, two, and three maturing eggs, approximately 12 by 8 mm.

Examination of the stomach contents of a few specimens indicates that the food of *Uma exsul* consists almost exclusively of small insects, particularly ants and beetles. No plant material was detected, but inasmuch as the specimens were all taken at the end of the dry season no succulent plants or buds were in evidence, and the absence of plant food in the diet may be seasonal. Stebbins (1944, p. 329) reports a few leaves and buds in the diet of *Uma inornata*, and he found a number of insects, particularly beetles, in the fecal pellets.

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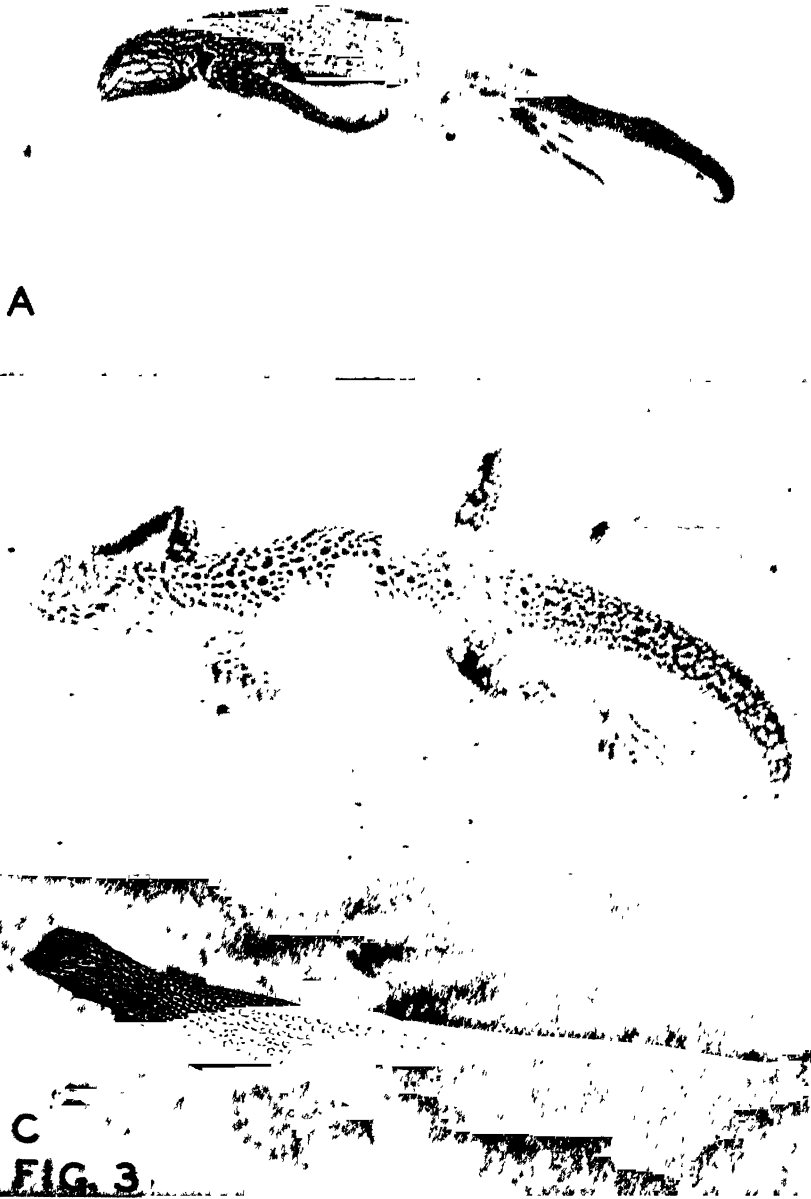


Fig. 3. A, Side view of paratype of *Uma exsul* (A.M.N.H. No. 67406) to show the black lateroventral blotches confluent with the black chevrons of the dorsal pattern. B, Dorsolateral view of *Uma exsul* (A.M.N.H. No. 67404, paratype, wounded individual photographed shortly after capture in abnormal posture due to injuries) to show habitus and pattern. C, Dorsolateral view of adult *Uma notata notata* (live specimen taken in the dunes west of Yuma, Arizona, in California). Compare pattern and profile with those of *Uma exsul* in upper photographs.

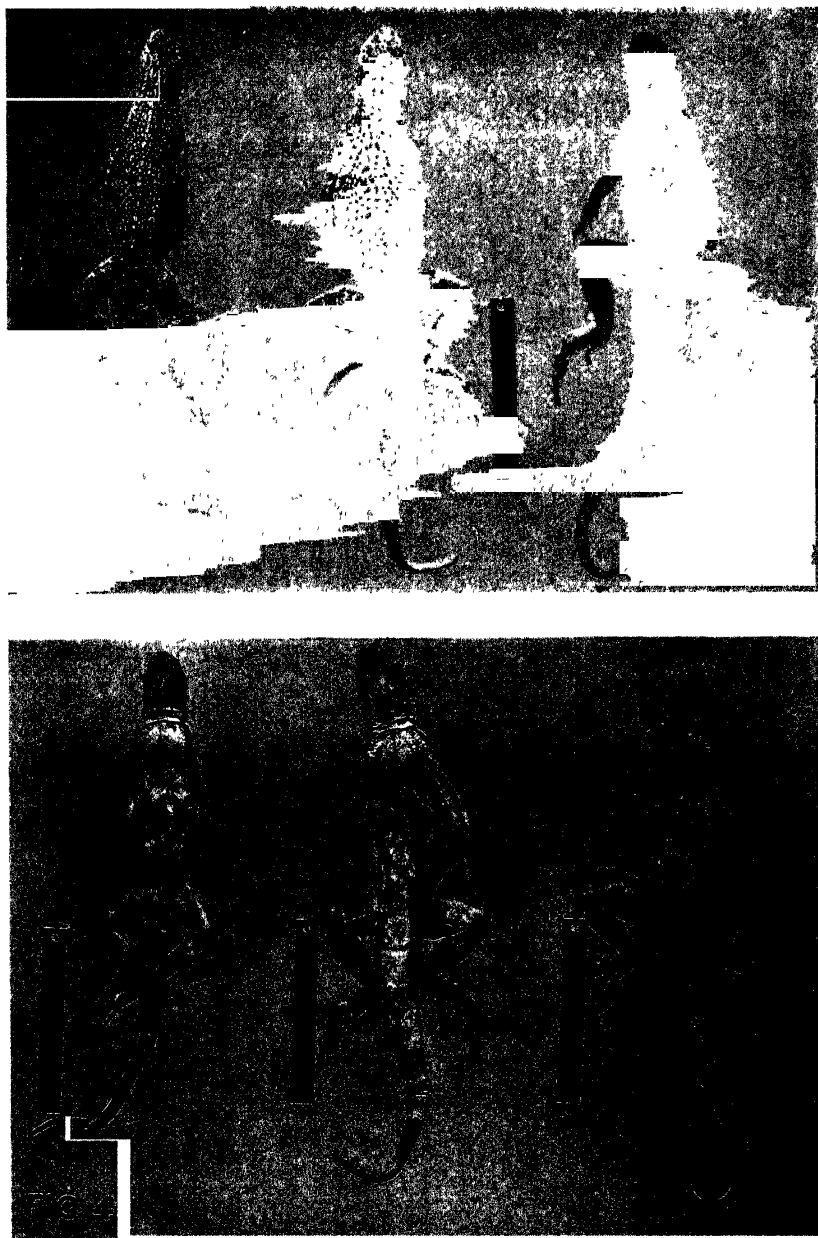


Fig. 4. Dorsal and ventral views of three paratypes of *Uma exsul* (A.M.N.H. Nos. 67408, 67406, 67407), to show variation in the pattern on three adult males.

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STUDIES OF THE PHALANGID FAUNA OF CENTRAL AMERICA

By CLARENCE J. AND MARIE L. GOODNIGHT¹

As a result of receiving several new collections, the writers have been able to continue their studies on the taxonomic and distributional problems of the Central American phalangids. In the study of these collections, the material from Central America at the Museum of Comparative Zoölogy, Cambridge, Massachusetts, was consulted. Here the authors were enabled to study various types through the kindness of Mr. Nathan Banks.

Dr. Alexander Petrunkevitch of Yale

University generously allowed the authors to study his collection of Central American phalangids. Types redescribed from these two collections are acknowledged in this paper.

The new species described below were collected mainly by Dr. and Mrs. Charles D. Michener with the assistance of Dr. Edson H. Fichter.

All holotypes of new species are deposited in the collection of the American Museum of Natural History.

SUBORDER LANIATORES THORELL

PHALANGODIDAE Simon

Phalangodinae Roewer

Cerroa floresia, new species

Figures 3-6

Metapachylus gracilis (nec Cambridge, 1904)
PETRUNKEVITCH, 1925, Trans. Connecticut Acad. Arts and Sci., vol. 27, p. 61.

Cerroa gracilis ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26, p. 533.

TYPE: Total length of body, 5.1 mm. Cephalothorax, 1.3 mm. Width of body at widest portion, 3.2 mm.

	I	II
Trochanter	0.2 mm.	0.3 mm.
Femur	1.1	2.3
Patella	0.3	0.4
Tibia	0.9	1.7
Metatarsus	1.2	2.1
Tarsus	1.1	1.8
Total	4.8 mm.	8.6 mm.
	III	IV
Trochanter	0.3 mm.	0.5 mm.
Femur	1.6	2.4
Patella	0.5	0.9
Tibia	1.2	2.1
Metatarsus	2.2	2.3
Tarsus	1.3	1.5
Total	7.1 mm.	9.7 mm.

Dorsal scute with five areas, the boundaries of which are parallel. First area without a median line. All areas and free tergites without median armature. Eye tubercle on the anterior margin of the cephalothorax, prolonged into a forward pointing spine. One large and several small spines present at the anterior-lateral margin of the cephalothorax. All dorsal areas and free tergites with transverse rows of small, hair-tipped tubercles. Free sternites with rows of hair-tipped tubercles. Anal operculum similarly armed. Spiracle not visible. Second coxa with several retrolateral spines; fourth coxa with a row of large lateral tubercles which are visible from above.

Legs: all segments except tarsi very tuberculate. A row of spines on the third femur. First femur with a dorsal and ventral row of spinose tubercles. Tarsal segments: 3-7-5-6. Distitarsus of first tarsus with two segments, second with three. Tarsal claws smooth, without false claw or scopula.

Palpus: trochanter, 0.3 mm. long; femur, 0.8 mm.; patella, 0.7 mm.; tibia, 0.6 mm.; and tarsus, 0.5 mm. Total length, 2.9 mm. Palpus armed retro-

¹ Department of Biology, Purdue University, West Lafayette, Indiana.

laterally as in figure 6. Prolaterally armed as follows: femur with one median apical spine; patella with one median spine; tibia with two spines; and tarsus with two.

Chelicera normal.

Color of entire animal reddish brown with darker mottlings. Appendages somewhat lighter.

TYPE LOCALITY: Type from Cerro Flores, Panama. Deposited in the collection of Dr. Alexander Petrunkevitch of Yale University, New Haven, Connecticut. The above description was made from the type specimen.

Pellobunus insularis Banks

Figures 14-16

Pellobunus insularis BANKS, 1905, Proc. Ent. Soc. Washington, vol. 7, p. 22, fig. 4a-d; ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 147; 1923, Die Weberknechte der Erde, p. 111, fig. 112.

TYPE: Total length of body, 2.6 mm. Cephalothorax, 0.8 mm. Width of body at widest portion, 2.1 mm.

	I	II
Trochanter	0.2 mm.	0.3 mm.
Femur	0.7	1.2
Patella	0.4	0.5
Tibia	0.5	1.0
Metatarsus	0.7	1.1
Tarsus	0.6	1.3
Total	3.1 mm.	5.4 mm.
	III	IV
Trochanter	0.2 mm.	0.3 mm.
Femur	0.9	1.0
Patella	0.4	0.6
Tibia	0.7	1.1
Metatarsus	1.1	1.4
Tarsus	0.7	0.8
Total	4.0 mm.	5.2 mm.

Dorsum with five distinct areas, the boundaries of which are parallel. First area without a median line. All areas and free tergites without median armature. All dorsal areas with many small, hair-tipped tubercles which are arranged more or less in rows. Eye tubercle clearly removed from the anterior margin of the cephalothorax, low, oval, unarmed except for small granulations. Each free tergite with a row of minute tubercles. Cephalothorax granulate. Each free sternite

with a transverse row of small tubercles, anal operculum granulate, venter and coxae granulate. Lateral teeth present on the anterior and posterior margins of coxa III, larger granulations present on the margins of coxae I and II. Spiracles not visible.

Legs clothed throughout with scattered hairs, smooth except for a few granulations on the fourth femur. Third and fourth femora slightly curved. Metatarsi not divided into astragali and calcanea. Tarsal segments: 4-6-5-6. Distitarsus of first tarsus with two segments, second with three. Tarsal claws smooth, without false claw or scopula.

Palpus: trochanter, 0.3 mm. long; femur, 0.7 mm.; patella, 0.4 mm.; tibia, 0.6 mm.; and tarsus, 0.5 mm. Total length, 2.5 mm. Palpus armed retrolaterally as in figure 15. Prolaterally armed as follows: femur with an apical median spine; patella with an apical median spine (this is visible in the drawing); tibia and tarsus each with two hair-tipped tubercles.

Chelicera normal, with scattered hairs.

Body light reddish brown, appendages yellowish.

TYPE LOCALITY: Type from Cocos Islands, Costa Rica. Type deposited in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type specimen.

ADDITIONAL RECORDS: Juan Mina, Canal Zone, Panama, February, 1945 (C. D. Michener); Barro Colorado Island, Canal Zone, March, 1945 (C. D. Michener).

STYGNOLEPTES BANKS

Stygnoleptes BANKS, 1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 682; ROEWER, 1931, Abhandl. Naturwiss. Ver. Bremen, vol. 28, p. 160.

Dorsal scute with five areas, the boundaries of which are parallel. First area without a median line. All dorsal areas and first free tergite without median armature. Second and third free tergites with median paired spines. Eye tubercle low, unarmed, removed from the anterior margin of the cephalothorax. Anal operculum with a long median spine. Spiracles concealed. Femur of palpus with an apical

median spine. Tarsal segments: 3-6-4-5. Distitarsus of first tarsus with two segments, second with three. Third and fourth tarsal claws without scopula, claws smooth.

GENOTYPE: *Stygnoleptes analis* Banks.

Stygnoleptes analis Banks

Figures 7-10

Stygnoleptes analis BANKS, 1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 682, pl. 28, figs. 6, 13; ROEWER, 1931, Abhandl. Naturwiss. Ver. Bremen, vol. 28, p. 160, fig. 25.

TYPE: Total length of body, 3.1 mm. Cephalothorax, 0.7 mm. Width of body at widest portion, 1.9 mm.

	I	II
Trochanter	0.2 mm.	0.3 mm.
Femur	0.7	1.1
Patella	0.4	0.6
Tibia	0.5	1.0
Metatarsus	0.7	1.4
Tarsus	0.6	1.1
Total	3.1 mm.	5.5 mm.

	III	IV
Trochanter	0.2 mm.	0.4 mm.
Femur	1.1	1.6
Patella	0.4	0.5
Tibia	0.7	1.1
Metatarsus	1.2	1.5
Tarsus	0.8	0.8
Total	4.4 mm.	5.9 mm.

Body pyriform, dorsum with five areas, the boundaries of which are parallel. Boundaries of areas not very distinct. First area without a median line. Dorsum very finely granulate, a row of small tubercles along the lateral margin of the scute. Median paired spines on the second and third free tergites. First free tergite and all dorsal areas without median armature. Eye tubercle low, unarmed, clearly removed from the anterior margin of the cephalothorax. Anal operculum tuberculate, with a long median spine. Free sternites finely granulate; coxae with larger granulations. Third coxa with anterior and posterior rows of teeth on the lateral borders. Spiracle hidden by a spine from the fourth coxa.

Legs clothed throughout with hairs. Femora and tibiae with small tuberculations, larger on the third femora. Fourth leg with heavy spines, arranged as in figure 7. Tibia of third leg slightly swollen. Tarsal segments: 3-6-4-5. Distitarsus of first tarsus with two segments; second, with three. Proximal segment of third tarsus elongate. Third and fourth tarsi without scopulae and without teeth on the claws.

Palpus: trochanter, 0.2 mm. long; femur, 0.5 mm.; patella, 0.3 mm.; tibia, 0.3 mm.; and tarsus, 0.3 mm. Total length, 1.6 mm. Palpus armed retrolaterally as in figure 10. Prolaterally armed as follows: femur with an apical median spine; patella with an apical median spine; tibia with three spine-bearing tubercles; and tarsus with two spine-bearing tubercles.

Chelicera normal, with a slight dorsal elevation on the proximal segment.

Entire animal light reddish brown, dorsal spines and palpus pale.

TYPE LOCALITY: Type from Turrialba, Costa Rica. Type deposited in the collection of the Museum of Comparative Zoology, Cambridge, Massachusetts. The above description was made from the type specimen.

COSMETIDAE Simon

Cosmetinae Cambridge

Cosmetus pulchrus Goodnight and Goodnight

Cosmetus pulchrus GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 4, fig. 18.

RECORD: Colon, Panama, March 17, 1945 (C. D. Michener).

Cynorta flavornata Banks

Figure 19

Cynorta flavornata BANKS, 1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 681; ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26, p. 559.

MALE: Total length of body, 5.5 mm. Cephalothorax, 1.8 mm. Width of body at widest portion, 4.9 mm.

	I	II
Trochanter	0.7 mm.	0.7 mm.
Femur	4.6	10.4
Patella	1.3	1.8
Tibia	2.8	8.3
Metatarsus	4.2	10.2
Tarsus	2.9	5.2

Total	16.5 mm.	36.6 mm.
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	III	IV
Trochanter	0.8 mm.	0.9 mm.
Femur	6.8	10.5
Patella	1.6	2.1
Tibia	3.7	5.4
Metatarsus	6.4	10.3
Tarsus	3.7	4.5

Total	23.0 mm.	33.7 mm.
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Dorsum smooth. Paired tubercles on the first area, paired spines on the third. Remaining dorsal areas and free tergites without median armature. Free sternites with transverse rows of small tubercles. Coxae somewhat granulate.

Legs clothed throughout with hairs. Basitarsus of first tarsus enlarged. Tarsal segments: 6-15-9-10. Distitarsus of first tarsus with three segments; second, with three segments.

Palpus: trochanter, 0.7 mm. long; femur, 1.5 mm.; patella, 0.8 mm.; tibia, 1.2 mm.; and tarsus, 0.8 mm. Total length, 5 mm. Palpus flattened, normal.

Chelicera normal.

Body reddish brown. Spines and tubercles of dorsal areas somewhat darker at the base, points of the spines lighter. White markings on dorsum as in figure 19. Two large white spots on the anal operculum, and a large white spot on the lateral portion of the fourth coxa. A white fleck over each eye and white flecks on the free tergites. Appendages yellowish, mottled with grayish brown.

TYPE LOCALITY: Type from San Jose, Costa Rica. Type deposited in the collection of the Museum of Comparative Zoology, Cambridge, Massachusetts. The above description was made from the type specimen.

Cynorta pleuralis Chamberlin

Cynorta pleuralis CHAMBERLIN, 1925, Bull. Mus. Comp. Zool., vol. 67, p. 241; ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26,

p. 567; GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 7, fig. 15.

RECORDS: Barro Colorado Island, Canal Zone, March 20, 1945, and October 25, 1945 (C. D. Michener). Piña, Colon Province, Republic of Panama, December 30, 1945 (C. D. Michener).

Cynortula pedalis (Banks)

Figure 20

Cynorta pedalis BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 227.

Eucynortella pedalis ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 53; 1923, Die Weberknechte der Erde, p. 327.

MALE: Total length of body, 5.5 mm. Cephalothorax, 2.0 mm. Width of body at widest portion, 4.4 mm.

	I	II
Trochanter	0.5 mm.	0.6 mm.
Femur	2.8	5.6
Patella	1.1	1.4
Tibia	2.1	4.5
Metatarsus	3.4	6.0
Tarsus	2.5	3.8

Total	12.4 mm.	21.9 mm.
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	III	IV
Trochanter	0.8 mm.	0.8 mm.
Femur	4.4	6.1
Patella	1.3	1.6
Tibia	2.7	3.8
Metatarsus	4.0	6.0
Tarsus	2.7	3.0

Total	15.9 mm.	21.3 mm.
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Dorsum finely granulate. First and third areas with median paired tubercles. Those of the third area are somewhat larger than those of the first. Remaining areas and free tergites without median armature. Free tergites and posterior margin of the fifth areas each with a transverse row of low tubercles. Venter and coxae smooth, with scattered hairs.

Legs smooth, with scattered hairs. Third and fourth legs of normal size, not enlarged over the first and second. Tarsal segments: 6-10-7-8. Distitarsus of first tarsus with three segments, second with three. Basitarsus of first tarsus slightly enlarged.

Palpus: trochanter, 0.8 mm. long; femur, 1.7 mm.; patella, 0.7 mm.; tibia, 1.5 mm.;

and tarsus, 0.6 mm. Total length, 5.3 mm. Palpus characteristically flattened.

Chelicera slightly enlarged.

Dorsum reddish brown. Color pattern as in figure 20.

TYPE LOCALITY: Type from San Isidro, Tristan, Costa Rica. Type deposited in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type specimen.

Cynortellana oculata (Banks)

Figure 38

Cynorta oculata BANKS, 1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 681.

Cynortula oculata ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen., vol. 26, p. 576.

Cynortellana circulata ROEWER, 1932, Ann. Naturhist. Mus. Bremen, vol. 46, pp. 283-284, fig. 7.

FEMALE: Total length of body, 5.1 mm. Cephalothorax, 1.2 mm. Width of body at widest portion, 3.8 mm.

	I	II
Trochanter	0.4 mm.	0.5 mm.
Femur	3.4	8.1
Patella	0.9	1.4
Tibia	2.0	6.7
Metatarsus	3.3	8.5
Tarsus	1.8	5.0
Total	11.8 mm.	30.2 mm.
	III	IV
Trochanter	0.7 mm.	0.7 mm.
Femur	5.7	8.1
Patella	1.3	1.4
Tibia	3.0	4.1
Metatarsus	5.4	8.0
Tarsus	2.2	3.6
Total	18.3 mm.	25.9 mm.

Dorsum smooth. First area with paired low spines; third area with paired large spines. Remaining areas and free tergites without median armature. Anal operculum, venter, and coxae with only scattered hairs.

Legs smooth. Tarsal segments: 6-14-9-9. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 0.4 mm. long; femur, 0.9 mm.; patella, 0.5 mm.; tibia, 0.9 mm.; and tarsus, 0.5 mm. Total length, 3.2 mm. Palpus normal, flattened.

Chelicera normal, proximal segment with some dorsal tuberculations.

Body dark reddish brown, mottled. Spines somewhat lighter. Each spine encircled by a white ring. Appendages yellowish, mottled with gray.

TYPE LOCALITY: Type from St. Maria, Costa Rica. Type in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type.

ADDITIONAL RECORDS: Waldeck Farm, Hamburg Farm, and Rio Parismina, Costa Rica. These localities were recorded by Roewer in 1932.

Eucynorta insularis (Banks)

Figure 21

Cynorta insularis BANKS, 1905, Proc. Ent. Soc. Washington, vol. 7, p. 22, fig. 5.

Metavonones insularis ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 28; 1923, Die Weberknechte der Erde, p. 308.

TYPE: Total length of body, 4.3 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 3.5 mm.

	I	II
Trochanter	0.5 mm.	0.5 mm.
Femur	1.9	4.5
Patella	0.8	1.1
Tibia	1.5	3.6
Metatarsus	2.5	5.0
Tarsus	1.4	3.3
Total	8.6 mm.	18.0 mm.
	III	IV
Trochanter	0.6 mm.	0.6 mm.
Femur	3.0	4.2
Patella	1.1	1.2
Tibia	1.9	2.3
Metatarsus	3.0	3.4
Tarsus	2.0	4.7
Total	11.6 mm.	16.4 mm.

Dorsum smooth except for a pair of low spines on the third area. Remaining areas and free tergites without median armature. Posterior margin of the fifth area and each free tergite with a transverse row of granulations. Venter and coxae with granulations and scattered hairs.

Legs clothed throughout with scattered hairs. A few granulations on the fourth femur, otherwise the segments are smooth. Tarsal segments: 6-13-7-9. Distitarsus of

first tarsus with three segments, second with three.

Palpus: trochanter, 0.6 mm. long; femur, 1.4 mm.; patella, 0.7 mm.; tibia, 1.4 mm.; and tarsus, 0.6 mm. Total length, 4.7 mm. Palpus characteristically flattened. A row of small tubercles on the ventral margin of the femur.

Chelicera normal.

Dorsum light reddish brown, with white markings as illustrated in figure 21. Legs pale yellowish. Palpus and chelicera concolorous with the body.

TYPE LOCALITY: Type from Cocos Island, Costa Rica. Type deposited in the collection of the Museum of Comparative Zoology, Cambridge, Massachusetts. The above description was made from the type.

***Eucynortella panamensis* Goodnight and Goodnight**

Eucynortella panamensis GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1184, p. 13, fig. 28.

RECORD: Old Panama City, Republic of Panama, February, 1945 (C. D. Michener).

***Eucynortoides parvulus* (Banks)**

Figures 23-24

Erginus parvulus BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 229.

Erginulus parvulus ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 82; 1923, Die Weberknechte der Erde, p. 353.

MALE: Total length of body, 3.2 mm. Cephalothorax, 1.2 mm. Width of body at widest portion, 2.7 mm.

	I	II
Trochanter	0.4 mm.	0.4 mm.
Femur	1.6	—
Patella	0.5	—
Tibia	1.1	—
Metatarsus	1.6	—
Tarsus	1.4	—
Total	6.6 mm.	
	III	IV
Trochanter	0.4 mm.	0.4 mm.
Femur	2.2	2.9
Patella	0.8	1.0
Tibia	1.4	1.7
Metatarsus	2.2	3.2
Tarsus	1.4	1.4
Total	8.4 mm.	10.6 mm.

Dorsum finely granulate. Paired spines on the third area; low paired tubercles on the first and fourth areas. Very small tubercles on either side of the median line on the second area; these are midway between the median line and the lateral border. A transverse row of tubercles across the posterior margin of the fifth area and across each free tergite. Eye tubercle with a few small tubercles over each carina. Venter and coxae with scattered hairs. Fourth coxa with a large dorsal apical spine. Anal operculum tuberculate.

Legs clothed throughout with hairs. Third and fourth trochanters each with a retrolateral apical spine. Tuberculations on all segments but the metatarsi and tarsi. Basal segments of third and fourth legs somewhat enlarged; fourth femur clavate, two rows of spines on the ventral side, dorsally tuberculate. Tarsal segments: 6-?-7-7. Distitarsus of first tarsus with three segments. Basitarsus of first tarsus slightly enlarged.

Palpus: trochanter, 0.5 mm. long; femur, 1.0 mm.; patella, 0.5 mm.; tibia, 0.8 mm.; and tarsus, 0.5 mm. Total length, 3.3 mm. Palpus characteristically flattened, with a ventral row of teeth on the femur.

Chelicera normal, second segment with a dorsal elevation.

Dorsum light reddish brown, spines lighter. Legs light. White markings of the dorsum as in figure 23.

TYPE LOCALITY: Type from San Isidro, Costa Rica. Type in the collection of the Museum of Comparative Zoology, Cambridge, Massachusetts. The above description was made from the type.

This species appears to be most closely related to *Eucynortoides brasiliensis* Roewer; however, the dorsal color pattern is considerably different. This species differs somewhat from the other members of the genus *Eucynortoides* by having the femur of the fourth leg somewhat enlarged.

***Eucynortula nannocornuta* (Chamberlin)**

Cynorta nannocornuta CHAMBERLIN, 1925, Bull. Mus. Comp. Zool., vol. 67, p. 242; ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26, p. 271; GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, pp. 6, 7, fig. 16.

Eucynortula dorsata GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 8, fig. 19.

Eucynortula sexpunctata GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 9, fig. 21.

The study of a long series of this species revealed that the specimens originally described represented extremes of variation in a single species.

RECORDS: Old Panama City, Republic of Panama, February, 1945 (C. D. Michener). La Campana, Republic of Panama, August 5, 1945 (E. H. Fichter). Santa Rosa, Colon Province, Republic of Panama, September, 1945 (C. D. Michener).

***Eupaecilaema panamaensis*, new species**

Figure 28

MALE: Total length of body, 4.8 mm. Cephalothorax, 1.8 mm. Width of body at widest portion, 4.2 mm.

	I	II
Trochanter	0.8 mm.	0.9 mm.
Femur	7.0	16.0
Patella	2.0	2.3
Tibia	13.5	12.0
Metatarsus	18.7	19.0
Tarsus	3.0	9.0
Total	45.0 mm.	59.2 mm.

	III	IV
Trochanter	1.2 mm.	1.2 mm.
Femur	12.0	16.0
Patella	2.0	1.7
Tibia	6.0	9.0
Metatarsus	12.0	17.0
Tarsus	5.0	6.5
Total	38.2 mm.	51.4 mm.

Dorsum smooth. Eye tubercle low, smooth. First and third areas with median paired tubercles. Remaining areas and free tergites without median armature. Free tergites without tuberculations. Venter and coxae smooth, with scattered hairs. A row of tuberculations across the first coxa; fourth coxa without dorsal apical spine.

Legs long and slender, clothed throughout with hairs. Several rows of small granulations on the femora. Tarsal segments: 7-18-10-12. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 0.9 mm. long; femur, 2.2 mm.; patella, 1.3 mm.; tibia, 2.1 mm.; and tarsus, 1.3 mm. Total length, 7.8 mm. Palpus characteristically flattened. Ventral margin of the femur with a row of small tuberculations.

Chelicera slightly enlarged, with a few scattered hairs.

Dorsum dark reddish brown, with a lighter brown mottled triangle crossing the eye tubercle. A netted yellow pattern covers most of the cephalothorax except the median section anterior to the eye tubercle. This netted pattern extends onto the abdominal scute, forming a border around the lateral and posterior margins. It is somewhat reduced on the lateral border in the region of the second area. This pattern is so arranged as to give a suggestion of a V between the cephalothorax and abdomen. A few light flecks on the median line. Scattered spots over the surface of the eye tubercle, free tergites without such markings. Venter and coxae dark reddish brown, chelicera and palpus lighter, with darker brown mottlings. Legs light brown, with much darker brown mottling on the patellae and apical portion of the femora.

FEMALE: Total length of body, 5.1 mm. Cephalothorax, 1.8 mm. Width of body at widest portion, 3.9 mm.

Similar to male in appearance, but without the enlarged chelicerae.

TYPE LOCALITY: Male holotype and male and female paratypes from Cerro Azul, Republic of Panama, January 1, 1945 (C. D. and M. Michener). Female paratype from Barro Colorado Island, Canal Zone, December, 1939 (E. C. Williams).

Eupaecilaema panamaensis is related to *E. magnum* Roewer from Costa Rica; however, the dorsal color pattern is different.

***Flirtea lateralis* (Banks)**

Figures 29-30

Vonones lateralis BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 228; ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 23; 1923, Die Weberknechte der Erde, p. 304. *Cymorta conspersa* (near C. L. Koch, 1839) BANKS, 1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 682.

Eucynorta conspersa ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26, pp. 582-583.

MALE: Total length of body, 5.0 mm. Cephalothorax, 1.6 mm. Width of body at widest portion, 4.1 mm.

	I	II
Trochanter	0.5 mm.	0.5 mm.
Femur	3.8	8.2
Patella	1.1	1.3
Tibia	2.4	7.2
Metatarsus	4.5	9.6
Tarsus	2.1	5.4
Total	14.4 mm.	32.2 mm.
	III	IV
Trochanter	0.6 mm.	0.9 mm.
Femur	5.8	8.1
Patella	1.4	1.7
Tibia	3.2	4.6
Metatarsus	5.5	7.8
Tarsus	2.7	3.6
Total	19.2 mm.	26.7 mm.

Dorsum finely granulate. First area with small paired median tubercles; third area with paired spines. Remaining areas and free tergites without median armature. Small scattered granulations over the dorsum, and a transverse row of larger ones across the fifth area and each free tergite. Venter and coxae with scattered hairs.

Legs: third and fourth legs somewhat larger than the first and second. Fourth femur tuberculate, armed distally as in figure 29; patella and tibia tuberculate. Tarsal segments: 6-15-11-13. Distitarsus of first tarsus with three segments, second with three. Basitarsus of first tarsus somewhat enlarged.

Palpus: trochanter, 0.8 mm. long; femur, 1.4 mm.; patella, 0.7 mm.; tibia, 1.4 mm.; and tarsus, 0.5 mm. Total length, 4.8 mm. Palpus characteristically flattened.

Chelicera normal.

Body reddish brown. Light pattern present as in figure 30. Granulations of the dorsum surrounded by white spots. A white spot on the fourth coxa. Several white spots on the anal operculum.

FEMALE: Total length of body, 4.6 mm. Cephalothorax, 1.6 mm. Width of body at widest portion, 4.5 mm.

Identical in appearance with the male, but with the spination of the femur of the fourth leg reduced.

TYPE LOCALITY: Male type from Turrialba, Costa Rica. Female from Juan Vinas, Costa Rica. Both types in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type material.

In the original descriptions by Banks, the name *Vonones lateralis* was given to a male specimen, and the name *Cynorta conspersa* was given to a female.

Flirtea picta (Perty)

Cosmetus pictus PERTY, 1833, Delectus animalium articulorum, fasc. 3, p. 208, pl. 40, fig. 5.

Flirtea picta C. L. KOCH, 1839, in Hahn, C. W., and C. L. Koch, Die Arachniden, vol. 7, p. 99, fig. 581.

Cosmetus pictus GERVAIS, 1844, in Walckenaer, C. A., and F. L. P. Gervais, Histoire naturelle des insectes. Aptères, vol. 3, p. 115.

Cynorta picta SIMON, 1879, Ann. Soc. Ent. Belgique, vol. 22, p. 200.

Flirtea picta ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 75; 1923, Die Weberknechte der Erde, p. 346, fig. 391.

RECORD: Cerro Azul, Republic of Panama, January 1, 1945 (C. D. Michener).

The specimens found agreed with the animal described by Roewer as *Flirtea picta* (Perty).

Meterginoides inermis (Banks)

Figures 25-26

Meterginus inermis BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 229.

Meterginoides inermis ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 103; 1923, Die Weberknechte der Erde, p. 379.

MALE: Total length of body, 5.6 mm. Cephalothorax, 2.4 mm. Width of body at widest portion, 4.6 mm.

	I	II
Trochanter	0.7 mm.	0.8 mm.
Femur	3.0	4.5
Patella	1.1	1.3
Tibia	2.2	3.8
Metatarsus	3.6	5.4
Tarsus	2.7	4.5
Total	13.3 mm.	20.3 mm.

	III	IV
Trochanter	0.8 mm.	1.1 mm.
Femur	3.6	4.8
Patella	1.1	1.5
Tibia	2.7	3.9
Metatarsus	4.1	5.4
Tarsus	3.2	3.6
Total	15.5 mm.	20.3 mm.

Dorsum smooth, clothed with scattered hairs. All dorsal areas and free tergites without median armature. Venter with scattered hairs. Each sternite with a transverse row of small tubercles. Fourth coxa with a dorsal apical spine.

Legs clothed throughout with hairs. Tuberculations on the femora. These tuberculations are larger on the third and fourth femora. Basal segments of the third and fourth legs somewhat enlarged. Fourth femur with several rows of tubercles on the ventral surface and several rows of small tubercles on the dorsal. These tubercles larger at the proximal portion. Tarsal segments: 7-14-8-8. Distitarsus of first tarsus with three segments, second with three. Basitarsus of first tarsus enlarged.

Palpus: trochanter, 0.5 mm. long; femur, 2.1 mm.; patella, 1.1 mm.; tibia, 1.8 mm.; and tarsus, 0.9 mm. Total length, 6.4 mm. Palpus normal, with a row of tubercles on the ventral portion of the femur.

Chelicera enlarged. A dorsal elevation on the proximal segment.

Entire animal reddish brown. White markings present as indicated in figure 25. Boundaries of areas and median line lighter.

TYPE LOCALITY: Type from Toblago, Costa Rica. Type in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type.

Paecilaemella eutypa (Chamberlin)

Figure 27

Meterginoides eutypa CHAMBERLIN, 1925, Bull. Mus. Comp. Zool., vol. 67, p. 240; ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26, p. 610; GOODNIGHT and GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 9.

TYPE: Total length of body, 5.9 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 4.1 mm.

	I	II
Trochanter	0.5 mm.	0.6 mm.
Femur	3.9	7.4
Patella	1.0	1.4
Tibia	2.3	7.2
Metatarsus	4.1	10.2
Tarsus	2.1	4.5
Total	13.9 mm.	31.3 mm.

	III	IV
Trochanter	0.7 mm.	0.8 mm.
Femur	6.5	9.1
Patella	1.7	1.5
Tibia	3.3	5.4
Metatarsus	6.3	9.2
Tarsus	3.0	3.2
Total	21.5 mm.	29.2 mm.

Dorsum smooth. All dorsal areas and free tergites without median armature. Eye tubercle low, unarmed. Venter, free sternites, and coxae with scattered hairs.

Legs long and slender. All segments entirely smooth except for scattered hairs. Tarsal segments: 7-17-10-11. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 0.5 mm. long; femur, 1.4 mm.; patella, 0.8 mm.; tibia, 1.2 mm.; and tarsus, 0.7 mm. Total length, 4.6 mm. Palpus flattened, normal. With a row of tuberculations on the ventral margin of the femur.

Chelicera normal. Proximal segment with a few tuberculations.

Body reddish brown. Yellow marking conspicuous, arranged as shown in figure 27. All appendages lighter.

TYPE LOCALITY: Type from Barro Colorado Island, Canal Zone (W. C. Allee). Type in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type.

ADDITIONAL RECORDS: Piña, Colon Province, Republic of Panama, December 30, 1945 (C. D. Michener).

Paecilaemana quadripunctata Goodnight and Goodnight

Paecilaemana quadripunctata GOODNIGHT and GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, pp. 9-10, fig. 25.

RECORD: Madden Forest, Canal Zone, October 2, 1945 (C. D. Michener). Santa

Rosa, Colon Province, Republic of Panama, September, 1945 (C. D. Michener).

Paracynorta confluens (Chamberlin)

Cynorta confluens CHAMBERLIN, 1925, Bull. Mus. Comp. Zool., vol. 67, p. 241; ROEWER, 1928, Abhandl. Naturwiss. Ver. Bremen, vol. 26, p. 570.

Paracynorta confluens GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 10, fig. 17.

RECORD: Santa Rosa, Colon Province, Republic of Panama, September, 1945 (C. D. Michener).

SOARESELLA, NEW GENUS

Dorsum with five areas. First, third, and fourth areas with median paired tubercles. The paired tubercles of the fourth area are much lower and closer together than those of the first and third. Anal operculum and free tergites without median armature, second and fifth areas likewise unarmed. Basal segments of the third and fourth legs not enlarged over those of the first and second. Tarsal segments: all with more than six. Distitarsus of first tarsus with three segments, second with three.

GENOTYPE: *Soaresella gracilis*, new species.

This genus is related to *Eupaecilaema* Roewer, differing by having paired median tubercles on the fourth area.

This genus is dedicated to Dr. and Mrs. B. M. Soares of the National Museum at Rio de Janeiro, Brazil.

Soaresella gracilis, new species

Figure 22

TYPE: Total length of body, 4.8 mm. Cephalothorax, 1.5 mm. Width of body at widest portion, 4.2 mm.

	I	II
Trochanter	0.5 mm.	0.7 mm.
Femur	5.3	15.0
Patella	1.0	1.1
Tibia	2.9	10.9
Metatarsus	5.4	12.8
Tarsus	2.1	7.0
Total	17.2 mm.	47.5 mm.

	III	IV
Trochanter	0.8 mm.	0.8 mm.
Femur	8.0	11.6
Patella	1.3	1.0
Tibia	3.9	5.9
Metatarsus	7.4	11.2
Tarsus	3.3	3.9
Total	24.7 mm.	34.4 mm.

Dorsum strongly arched, smooth. The abdomen covered with small white spots, many of which are slightly elevated. Free tergites entirely smooth. First, third, and fourth areas with paired tubercles. Second and fourth areas without median armature. The paired tubercles of the fourth area somewhat smaller and much closer together than those of the preceding areas. Anal operculum and free sternites with granulations; granulations arranged in rows on the free sternites. Venter and coxae with scattered hairs. Lateral proximal surface of the fourth coxa with a few small tubercles, which are visible from above. Distal portion of fourth coxa without a spine.

Legs long and thin, smooth, with a few scattered hairs. Basal segments of third and fourth legs not enlarged over those of the first and second. Tarsal segments: 7-19-12-15. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 0.5 mm. long; femur, 1.3 mm.; patella, 0.7 mm.; tibia, 1.3 mm.; and tarsus, 0.6 mm. Total length, 4.4 mm. Palpus characteristically flattened, covered with scattered hairs. A row of teeth on the ventral margin of the femur.

Chelicera normal, with scattered hairs. Not enlarged, a few granulations on the elevated portion of the first segment.

Dorsum dark velvety brown, cephalothorax lighter with darker mottlings. A broad white band begins at the region of the second coxa and forms a lateral border to the remainder of the dorsum. A few brown spots scattered irregularly in this band. Free tergites also white. Paired tubercles of the first, third, and fourth areas white. Scattered white spots over the entire abdominal scute, a few white spots on the cephalothorax. Dorsum without a white V or median line. Venter and coxae dark brown, the small tubercles on the lat-

eral portion of the fourth coxa white. Dorsal half of anal operculum with several irregular white spots. Patellae of legs dark brown; remaining segments, including the trochanter, yellow. Palpus and chelicera dark brown, mottled with lighter.

TYPE LOCALITY: Type from 3 miles north of Summit, Canal Zone, Panama, April 8, 1945 (C. D. Michener).

GONYLEPTIDAE Sundevall

Cranainae Roewer

BARRONA GOODNIGHT AND GOODNIGHT

Baronna GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 11.

The generic description of *Barrona* should be modified as follows:

Dorsal scute with four areas. First area with an indefinite median line. First and third areas with paired median spines. Fourth area with paired median tubercles. Second area without median armature. First, second, and third free tergites, each with median paired low spines. Eye tubercle with paired low spines. Fourth coxa not widened laterally. Femur of palpus without median apical or dorsal apical spine. Tarsal segments: 6—more than 6—more than 6. Distitarsus of first tarsus with three segments; second, with three.

GENOTYPE: *Barrona williamsi* Goodnight and Goodnight.

Barrona williamsi Goodnight and Goodnight

Figures 1-2

Barrona williamsi GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 11, fig. 26.

RECORD: Juan Mina, Canal Zone, February, 1945 (C. D. Michener). Barro Colorado Island, Canal Zone, March 20, 1945 (C. D. Michener).

Santinezia micheneri, new species

Figures 31-33

FEMALE: Total length of body, 8.0 mm. Cephalothorax, 3.8 mm. Width of body at widest portion, 5.7 mm.

	I	II
Trochanter	1.0 mm.	1.2 mm.
Femur	6.5	14.1
Patella	1.5	2.1
Tibia	4.0	11.0
Metatarsus	6.5	12.5
Tarsus	2.5	7.5
Total	22.0 mm.	48.4 mm.
	III	IV
Trochanter	1.6 mm.	1.5 mm.
Femur	12.0	14.2
Patella	2.2	2.7
Tibia	11.0	8.5
Metatarsus	13.5	14.5
Tarsus	4.0	5.0
Total	44.3 mm.	46.4 mm.

Dorsum with four areas. First area with a median line. First area with paired tubercles, a smaller tubercle laterad to each of the median tubercles. Second area without median armature, but with a row of small tubercles on either side of the median division. Third area with a pair of large spines, two small tubercles laterad to each spine. A pair of small tubercles in the median posterior portion of the third area. Fourth area with only two small tubercles near the lateral margin. Lateral margin of scute with a few small tubercles in the region of the fourth coxa. First free tergite with only a few tubercles at the lateral portion. Second and third free tergites each with a median pair of spines, those of the second free tergite larger than those of the third. A few small tubercles at the lateral margin of the second and third free tergites. Anterior margin of the cephalothorax with a median projection between the chelicerae and with a row of several tubercles at the lateral portion. Eye tubercle robust, with a pair of large spines. A few small tubercles posterior to each of these spines. Anal operculum with a few scattered tubercles. Each free sternite with a transverse row of small hair-tipped tubercles. Coxae covered with scattered hair-tipped tubercles, some of these arranged as indefinite transverse rows across each; tubercles of the first coxa longer. A large heavy tubercle in the mid-ventral portion of the fourth coxa; a dorsal apical spine also present on the fourth coxa which is not widened laterally.

Legs: trochanters tuberculate, these tubercles particularly heavy on the third and fourth ones. All segments of the legs clothed with scattered hairs. Femora and patellae with tuberculations which are arranged more or less in rows on the femora. The tuberculations of the third and fourth femora very heavy, a small spine at the distal dorsal portion of the third femur, two smaller ones at the distolateral portion. Fourth femur with three large distal spines on the prolateral surface, two spines in one row, the other separated. All spines curved. A small apical spine at the retrolateral apical margin. A few tuberculations on the fourth tibia. Tarsal segments: 8-15-9-11. Distitarsus of first tarsus with three segments, second with three. Tarsal claws simple, and tarsi without scopulae. Third and fourth femora straight.

Palpus: trochanter, 1.3 mm. long; femur, 4.0 mm.; patella, 2.0 mm.; tibia, 2.7 mm.; and tarsus, 2.5 mm. Total length, 12.5 mm. Palpus armed retrolaterally as in figure 33. Prolaterally armed as follows: femur has a few tubercles at the distal third, without median apical spine, but with a dorsal apical spine; patella with only a few small tuberculations; tibia with four spines, the penultimate one being the largest; tarsus with two spines and several very small spines.

Chelicera somewhat enlarged, first segment with a few scattered tubercles. Second segment with scattered hairs and with two heavy tubercles in the median anterior portion.

Dorsum light brown, with darker mottlings. Spines of the eye tubercle lighter. A large white spot at the lateral portion of the second and third areas, a double white line beginning behind the eye tubercle and extending to the spines of the third area. First and second areas outlined in white as in figure 31. Median spines of the second and third free tergites white. Third free tergite with a posterior strip of white and a few white flecks in the median portion of all free tergites. Venter dark brown, appendages dark brown, mottled with lighter brown.

MALE: Total length of body, 10.2 mm.

Cephalothorax, 4.2 mm. Width of body at widest portion, 9.1 mm.

Similar in appearance to the female. Chelicera enlarged; the large tubercles on the ventral surface of the fourth coxa of the female are prolonged into spines on the male.

TYPE LOCALITY: Female holotype from Barro Colorado Island, Canal Zone, March 20, 1945 (C. D. Michener). Male and female paratypes from El Valle de Antón, Coclé Province, Republic of Panama, December 22, 1945 (C. D. Michener). The holotype was taken in a small tree hole; the paratypes were among leaves of arboreal bromeliads and beneath leaf sheaths of banana plants.

Santinezia micheneri is related to *Santinezia albilineata* Roewer. The color pattern of the dorsum is different, however.

Zygopachylus albimarginis Chamberlin

Zygopachylus albimarginis CHAMBERLIN, 1925, Bull. Mus. Comp. Zool., vol. 67, p. 243; ROEWER, 1929, Abhandl. Naturwiss. Ver. Bremen, vol. 27, p. 231; GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 12, fig. 28.

Panamella gracilis ROEWER, 1932, Arch. Naturgesch., new ser., vol. 1, no. 2, p. 314, fig. 30.

A series of *Zygopachylus albimarginis* Chamberlin was found on examination to be a member of the subfamily Cranainae. It is identical with *Panamella gracilis* Roewer. The differences in generic diagnoses between Roewer and the authors are due to variations in different individuals. In some specimens the three spinules over each eye are of equal length, hence could hardly be considered paired. In others the median ones are larger and would be considered paired spines as Roewer has stated. The same holds true for the first area, some specimens having distinctly paired tubercles. This same variation is also found in the median tubercles of the first and second free tergites. The lateral rows of tubercles may vary in color from shining white to a pale yellow.

RECORD: Barro Colorado Island, Canal Zone, March 20, 1945 (C. D. Michener). Madden Forest, Republic of Panama, January 18, 1945 (C. D. Michener). Piña, Colon Province, Republic of Panama, December 30, 1944 (C. D. Michener).

Gonyleptinae Simon

Glysterus scutatus Roewer

Glysterus scutatus ROEWER, 1931, Abhandl. Naturwiss. Ver. Bremen, vol. 28, p. 163, fig. 26.

Rooma caudaspina GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1184, p. 16, fig. 35.

Some females in a long series of *Rooma caudaspina* Goodnight and Goodnight were found to be identical with the drawing of *Glysterus scutatus* Roewer. Roewer's drawing is of a female rather than a male. While the dorsal areas are not clear, four may be distinguished in some specimens. Hence the authors feel that *G. scutatus* Roewer can be placed in the subfamily Gonyleptinae.

HERNANDRIA BANKS

Hernandria BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 230; ROEWER, 1913, Arch. Naturgesch., vol. 79, sect. A, no. 5, p. 463; 1923, Die Weberknechte der Erde, p. 583.

Dorsum with four areas, first area without a median line. First and second areas with median paired tubercles, third area with median paired low spines. Second free tergite with a median spine. Fourth area and first and third free tergites without median armature. Eye tubercle oval, with a small spine over each eye. Fourth coxa widened laterally, with a dorsal apical spine. Tarsal segments: 6—more than 6—6—6. Distitarsus of first tarsus with three segments, second with three. Tarsal claws smooth, no scopula present; false claw of the third and fourth tarsi very large. Femur of patella without dorsal apical or median apical spines.

GENOTYPE: *Hernandria spinosa* Banks.

Hernandria spinosa Banks

Figures 34–35

Hernandria spinosa BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 230; ROEWER, 1913, Arch. Naturgesch., vol. 79, sect. A, no. 5, p. 463; 1923, Die Weberknechte der Erde, p. 583.

TYPE: Total length of body, 4.2 mm. Cephalothorax, 1.5 mm. Width of body at widest portion, 3.5 mm.

	I	II
Trochanter	0.5 mm.	0.7 mm.
Femur	1.9	3.5
Patella	0.8	1.0
Tibia	1.4	2.6
Metatarsus	2.3	3.2
Tarsus	1.4	2.9
Total	8.3 mm.	13.9 mm.
	III	IV
Trochanter	0.7 mm.	0.6 mm.
Femur	2.8	3.4
Patella	1.1	1.4
Tibia	1.6	2.2
Metatarsus	2.5	3.6
Tarsus	2.0	2.2
Total	10.7 mm.	13.4 mm.

Dorsum finely granulate, with four areas. First area without a median line. First and second areas with median paired tubercles. Third area with median paired low spines. Second free tergite with a median spine. Fourth area and first and third free tergites without median armature. A few very small tubercles along the lateral margin of the dorsal scute, a small tubercle laterad to the spines of the third area. A transverse row of small tubercles on the second and third free tergites. Anal operculum with a few scattered tubercles. Eye tubercle oval, with a small spine and a few minute tubercles over each eye. Anterior margin of cephalothorax smooth. Venter, coxae, and free sternites with transverse rows of tubercles. Venter and coxae with scattered tuberculations. A transverse row of tuberculations across the first to third coxae. Fourth coxa with dorsal and lateral tubercles which are visible from above. A dorsal apical spine present on the fourth coxa; this coxa is widened laterally.

Legs clothed throughout with hairs, all segments but the tarsi with hair-tipped tuberculations. These are larger on the fourth leg. Fourth trochanter with an apical retrolateral spine. Tarsal segments: 6–11–6–6. Distitarsus of first tarsus with three segments, second with three. Tarsal claws smooth, no scopula present. The false claw of the third and fourth tarsi very large.

Palpus: trochanter, 0.5 mm.; femur, 1.4 mm.; patella, 0.7 mm.; tibia, 1.0 mm.;

and tarsus, 0.8 mm. Total length, 4.4 mm. Palpus armed retrolaterally as in figure 35. Prolaterally armed as follows: femur and patella unarmed; tibia and tarsus, each with four spine-tipped tubercles, two large and two small. No apical median or apical dorsal spines on either the femur or patella.

Chelicera slightly enlarged, a slight bulge on the prolateral surface of the proximal segment. Both segments smooth except for scattered hairs.

Entire animal reddish brown with a median lighter line. Tarsi and palpus somewhat lighter.

TYPE LOCALITY: Type from Santa Maria Dota, Costa Rica. Type in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type.

PARAHERNANDRIA, NEW GENUS

Hernandria (part) BANKS, 1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 680; ROEWER, 1931, Abhandl. Naturwiss. Ver. Bremen, vol. 28, p. 163.

Dorsum with four areas, first area with a median line. Low paired tubercles on the first, second, and third areas. Second free tergite with a median spine. Fourth area and first and third free tergites without median armature. Fourth coxa widened laterally, fourth femur with spines. Tarsal segments: 5-more than 6-6-6. Distitarsus of first tarsus with three segments, second with three. Tarsal claws smooth; tarsi without scopulae. Femur of palpus without median apical or dorsal apical spines.

GENOTYPE: *Parahernandria ventralis* (Banks).

Parahernandria is related to *Hernandria* Banks; however, the first tarsus has five rather than six segments, the first area has a median line, and the armature of the palpus differs.

Parahernandria ventralis (Banks)

Figures 36-37

Hernandria ventralis BANKS, 1914, Proc. Acad. Nat. Sci. Philadelphia, vol. 65, p. 680; ROEWER, 1931, Abhandl. Naturwiss. Ver. Bremen, vol. 28, p. 163.

FEMALE: Total length of body, 4.7 mm. Cephalothorax, 1.5 mm. Width of body at widest portion, 3.5 mm.

	I	II
Trochanter	0.3 mm.	0.4 mm.
Femur	1.4	2.2
Patella	0.5	0.7
Tibia	1.0	1.6
Metatarsus	1.5	2.0
Tarsus	1.1	1.8
Total	5.8 mm.	8.7 mm.
	III	IV
Trochanter	0.4 mm.	0.6 mm.
Femur	1.9	2.2
Patella	0.8	0.9
Tibia	1.3	1.6
Metatarsus	1.8	2.5
Tarsus	1.2	1.4
Total	7.4 mm.	9.2 mm.

Dorsum finely granulate, with four areas. First area with a median line. Low paired tubercles on the first, second, and third areas. Second free tergite with a median spine. Third area with a pair of tubercles laterad to the median tubercles. Fourth area and free tergites, each with a transverse row of small tubercles. A row of tubercles on the bulge of the lateral margin. Eye tubercle rounded, a row of small tubercles over each eye. Anterior margin of the cephalothorax smooth except for two small spines at the anterior lateral border. Underneath the margin of the cephalothorax, a median projection which extends between the chelicerae. Venter and coxae smooth, a transverse row of small tubercles across the first coxa. Each free sternite with a transverse row of small tubercles. Anal operculum tuberculate; fourth coxa widened laterally, tuberculate dorsally and laterally, and with a dorsal apical spine.

Legs clothed throughout with hairs. All segments but the tarsi and metatarsi with hair-tipped tubercles which are arranged more or less in rows; these tubercles are larger on the fourth leg. The trochanter of the fourth leg with a spine on the apical retrolateral portion and one spine on the distal portion of the femur, another on the distal portion of the patella. Tarsal segments: 5-7 or 8-6-6. Distitarsus of first tarsus with three segments, second with three. Tarsal claws smooth, without scopulae.

Palpus: trochanter, 0.3 mm. long; femur, 1.4 mm.; patella, 0.5 mm.; tibia, 0.8 mm.;

and tarsus, 0.8 mm. Total length, 3.8 mm. Palpus armed retrolaterally as in figure 36. Prolaterally armed as follows: femur and patella unarmed; tibia and tarsus, each with two large and two small spine-tipped tubercles.

Chelicera normal, clothed throughout with hairs. First segment with a small dorsal elevation.

Body reddish brown, darker brown mottlings present. With a lighter median line on the dorsum. Tubercles and median spine light, a light area around each tubercle. Appendages yellowish, with much dark brown mottling.

TYPE LOCALITY: Type from Santa Maria Dota, Costa Rica. Type in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type.

SUBORDER PALPATORES THORELL

Tribe **EUPNOI** Hansen and Soerensen

PHALANGIDAE Simon

Gagrellinae Thorell

Geaya annulipes (Banks)

Leiobunum annulipes BANKS, 1909, Proc. Acad. Nat. Sci. Philadelphia, vol. 61, p. 232; ROEWER, 1923, Die Weberknechte der Erde, p. 1088.

Prionostemma annulipes ROEWER, 1910, Abhandl. Ver. Hamburg, vol. 19, no. 4, p. 171.

FEMALE: Total length of body, 5.7 mm. Cephalothorax, 1.3 mm. Width of body at widest portion, 3.6 mm. Length of femora: I, 7.2 mm.; II, 12.4 mm.; III, 7.2 mm.; IV, 10.1 mm.

Dorsum coarsely granulate. Eye tubercle slightly canaliculate, smooth above. Venter and coxae granulate. A row of teeth present on the anterior margins of all coxae and on the posterior margins of the first and fourth coxae. Supracheliceral lamella prolonged into an obtuse projection.

Legs clothed with scattered hairs. Nodules: 0-3-0-0.

Palpus: trochanter, 0.3 mm. long; femur, 1.3 mm.; patella, 0.4 mm.; tibia, 0.8 mm.;

and tarsus, 1.4 mm. Total length, 4.2 mm. Palpus clothed throughout with hairs. Patella with an apophysis.

Chelicera normal.

Body yellowish, with darker brown mottlings. A median lighter stripe surrounded by darker on the dorsum. Eye tubercle light, eyes ringed with black. Coxae with much darker brown markings. Trochanters likewise mottled. Legs light brown, femora and tibiae with narrow yellow rings, giving a striking annulate appearance. Remainder of legs mottled. Palpus and chelicera mottled.

TYPE LOCALITY: Type from Tablazo, Tristan, Costa Rica. Type in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The above description was made from the type.

Pachylinae Roewer

Hernandariodes plana Cambridge

Figures 17-18

Hernandariodes plana CAMBRIDGE, 1904, Biologia Centrali-Americana, Arachnida, vol. 2, p. 574, pl. 54, figs. 1, 1a; ROEWER, 1913, Arch. Naturgesch., vol. 79, sect. A, no. 5, p. 464; 1923, Die Weberknechte der Erde, p. 583.

Kaluga elongata GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1184, p. 18, fig. 33.

A restudy of the type of *Kaluga elongata* leads the writers to believe that their species is the same as that described by Cambridge.

Nesopachylus monoceras Chamberlin

Nesopachylus monoceras CHAMBERLIN, 1925, Bull. Mus. Comp. Zool., vol. 67, p. 244; ROEWER, 1929, Abhandl. Naturwiss. Ver. Bremen, vol. 27, p. 228; GOODNIGHT AND GOODNIGHT, 1942, Amer. Mus. Novitates, no. 1198, p. 13, fig. 27.

RECORD: Juan Mina, Canal Zone, February 1, 1945 (C. D. Michener).

Prionostemma fichteri, new species

Figure 13

MALE: Total length of body, 2.5 mm. Cephalothorax, 1.2 mm. Width of body at widest portion, 2.6 mm. Length of femora: I, 11.4 mm.; II, 19.1 mm.; III, 10.2 mm.; IV, 15.1 mm.

Entire body, dorsum, venter, and coxae thickly covered with rounded flat elevations, giving the whole animal a marked reticulate appearance. Eye tubercle at the posterior third of the cephalothorax, somewhat constricted at the base, canaliculate smooth above, with a few tuberculations over each eye. Supracheliceral lamella in the form of an expanded plate, median portion of which projects. All coxae with anterior and posterior rows of teeth; the individual teeth are large and usually end in four or five acute points.

Legs clothed throughout with hairs. All segments except metatarsi and tarsi with a few small spines which are arranged more or less in rows. Nodules: 0-3-0-1.

Palpus: trochanter, 0.2 mm. long; femur, 1.1 mm.; patella, 0.4 mm.; tibia, 0.6 mm.; and tarsus, 1.1 mm. Total length, 3.4 mm. Apophysis of the patella, 0.1 mm. long. Palpus but slightly elevated above the anterior margin of the cephalothorax. Clothed throughout with hairs which are very numerous on the tarsus, many investing hairs also present on the tarsus. A row of small spines on the ventral margin of the femur and a few small scattered spines on the dorsal portion of the femur and patella. Patella with a rounded apophysis which is covered with hairs.

Chelicera normal, with a few scattered hairs.

Dorsum golden yellow. Eye tubercle dark brown to black. A small dark brown spot on the surface of the cephalothorax just posterior to the eye tubercle. A dark brown stripe in the median portion of the posterior part of the abdominal scute. This stripe is extended onto the anal operculum, where it widens. In some specimens this dark stripe is broad and is continuous from the eye tubercle to the anal operculum; in some it is reduced to only a spot on the anal operculum. Venter and coxae concolorous with the gold of the dorsum. Trochanters and bases of femora very dark brown, contrasting strongly with the coxae. Remainder of legs light brown. Patellae and distal portion of femora somewhat lighter than the remainder of the legs. Palpus and chelicera yellow, the tips of the cheliceral claws black.

FEMALE: Total length of body, 4.7 mm. Cephalothorax, 1.7 mm. Width of body at widest portion, 3.7 mm.

Identical in appearance with the male.

TYPE LOCALITY: Male holotype and male and female paratypes from Chagres River, Santa Rosa, Colon Province, Republic of Panama, December 22, 1944 (C. D. Michener). Additional male and female paratypes from the following localities: Cerro Azul, Republic of Panama, January 1, 1945 (C. D. and M. Michener); La Campana, Republic of Panama, August 5, 1935 (E. H. Fichter); Piña, Colon Province, Republic of Panama, December 30, 1944 (C. D. Michener); and Barro Colorado Island, Canal Zone, July 5, 1938 (A. Petrunkevitch). The specimens from the last locality are in the collection of Dr. Alexander Petrunkevitch of Yale University, New Haven, Connecticut.

Prionostemma fuscamaculata, new species

Figures 11-12

MALE: Total length of body, 3.1 mm. Cephalothorax, 1.1 mm. Width of body at widest portion, 2.4 mm. Length of femora: I, 9.2 mm.; II, 14.8 mm.; III, 8.7 mm.; IV, 12.1 mm.

Dorsum covered with small depressions of varying sizes (0.05-0.1 mm.), giving a reticulate appearance. Eye tubercle canaliculate, with a row of very small tubercles over each carina. Eye tubercle at posterior third of cephalothorax. Supracheliceral lamella extended medially into a projection. Venter and coxae covered with small tuberculations. Lateral teeth present on the anterior and posterior margins of all coxae. Each lateral tooth with three points.

Legs clothed throughout with hairs and investing hairs present on the tibiae, metatarsi, and tarsi. A few small spines present on the basal segments of the legs. Nodules: 0-3-0-1. Nodules very small.

Palpus: trochanter, 0.3 mm. long; femur, 0.8 mm.; patella, 0.4 mm.; tibia, 0.6 mm.; and tarsus, 1.1 mm. Total length, 3.2 mm. Apophysis of the patella, 0.1 mm. long. Palpus clothed throughout with hairs.

Femur only slightly elevated above the margin of the cephalothorax. Investing hairs present on the tarsus. Ventral portion of the femur with a row of small spines. Patella and tibia covered with small brownish spines, a rounded apophysis present on the patella.

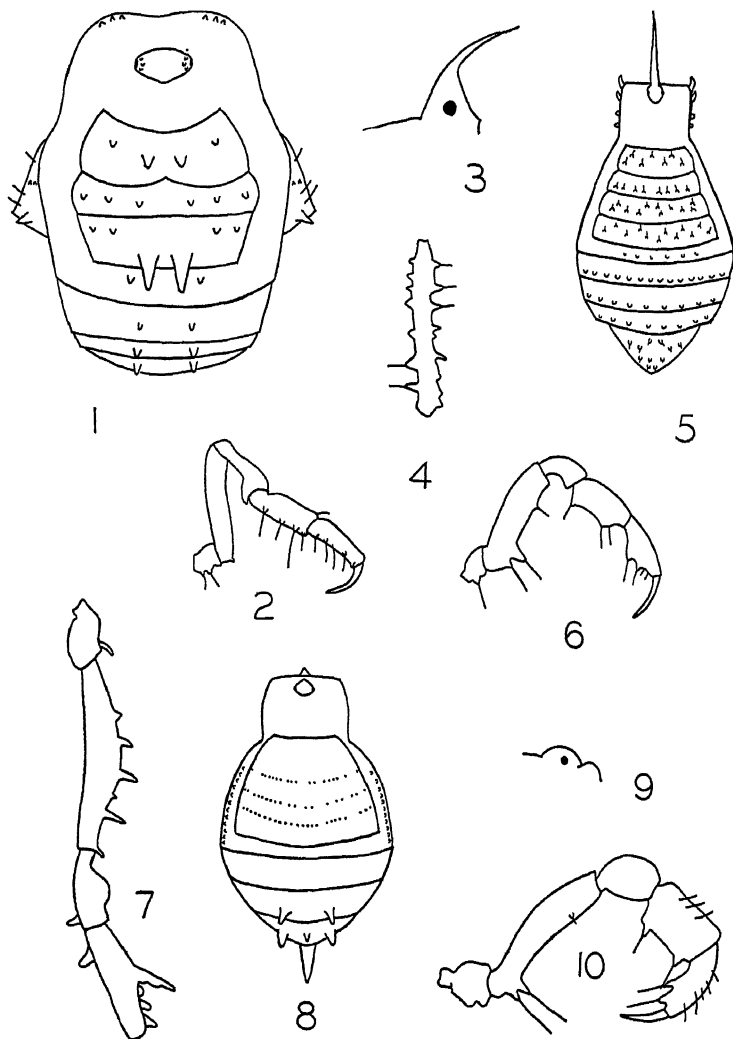
Dorsum yellowish, eye tubercle dark brown, light brown posterior to the eye tubercle. Abdomen with two parallel rows of dark brown, the darker color being found only on the raised reticulate portion. These parallel rows of darker brown are missing in some specimens. The same dark markings extend laterally to the margin in the region of the fourth coxa. Some darker shading present on the posterior portion of the scute. Venter and coxae

yellow, trochanters and bases of femora brown on the anterior and posterior margins, contrasting slightly. Remainder of legs lighter brown. Palpus and chelicera yellowish, tips of cheliceral claws black.

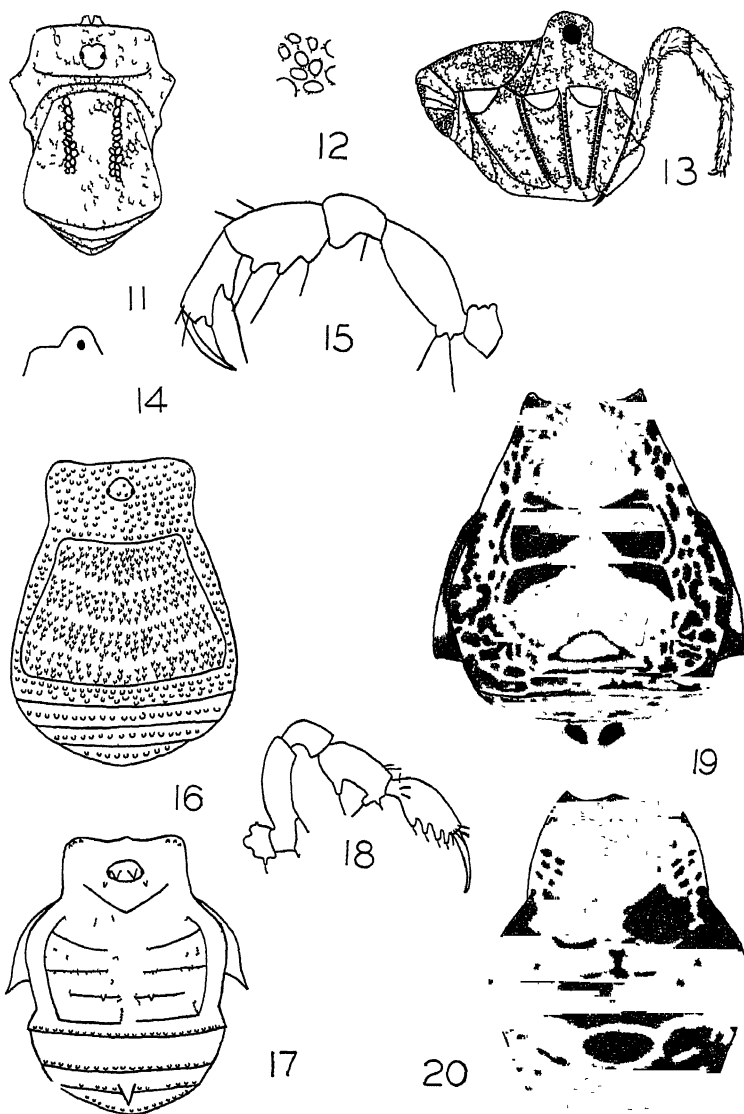
FEMALE: Total length of body, 3.4 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 2.9 mm.

Identical in appearance with the male.

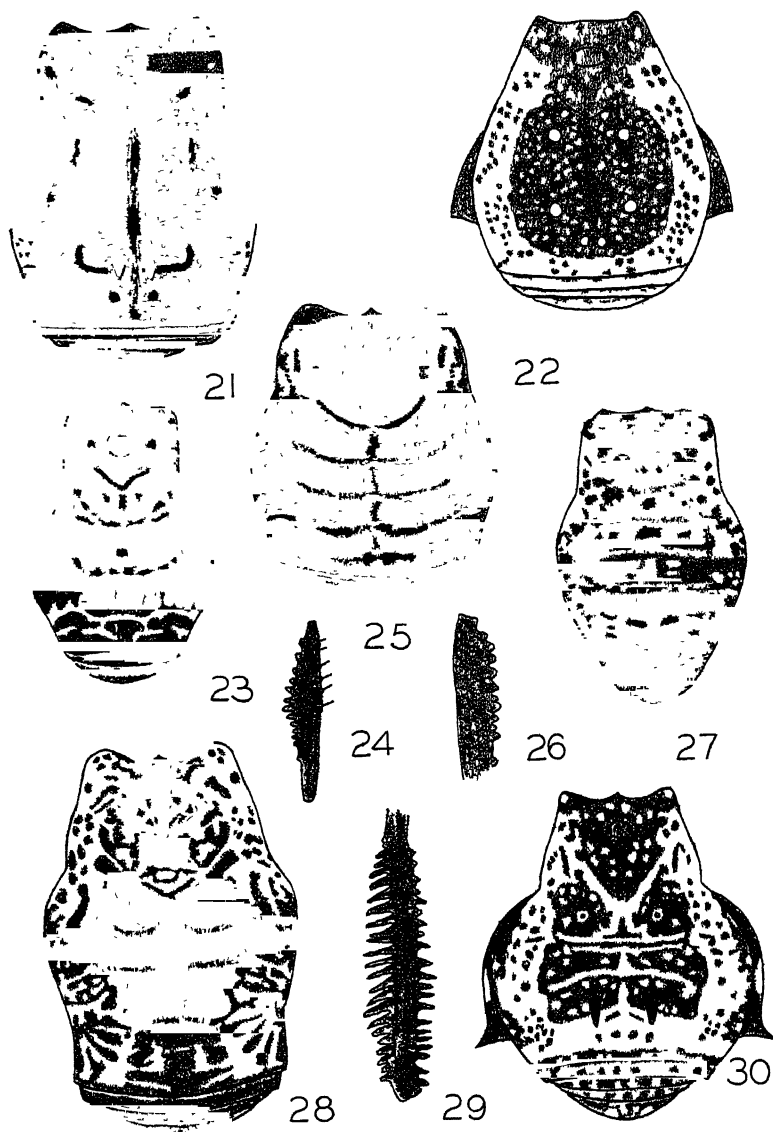
TYPE LOCALITY: Male holotype from Old Panama City, Republic of Panama, February, 1945 (C. D. Michener). Male and female paratypes from the same locality, February, 1945, and August, 1945 (C. D. Michener and E. H. Fichter). Male and female paratypes from Santa Rosa, Colon Province, Republic of Panama, September, 1945 (C. D. Michener).



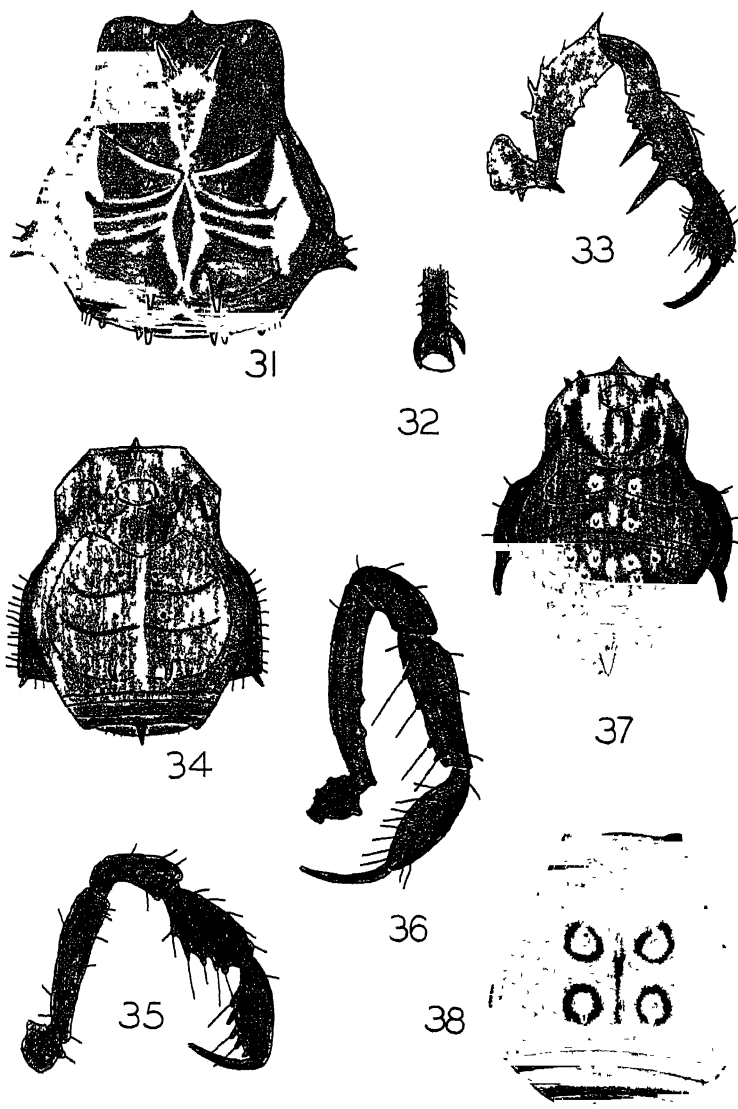
- Fig. 1. *Barrona williamsi* Goodnight and Goodnight, dorsal view of male.
 Fig. 2. Idem, retrolateral view of palpus.
 Fig. 3. *Cerroa floresia*, new species, lateral view of eye tubercle of type.
 Fig. 4. Idem, dorsal view of femur of first leg of type.
 Fig. 5. Idem, dorsal view of type.
 Fig. 6. Idem, retrolateral view of palpus of type.
 Fig. 7. *Stygnoleptes analis* Banks, prolateral view of left femur of fourth leg of type.
 Fig. 8. Idem, dorsal view of type.
 Fig. 9. Idem, lateral view of eye tubercle of type.
 Fig. 10. Idem, retrolateral view of palpus of type.



- Fig. 11. *Prionostemma fuscamaculata*, new species, dorsal view of male.
 Fig. 12. Idem, view of a section of the dorsum.
 Fig. 13. *Prionostemma fichieri*, new species, lateral view of male.
 Fig. 14. *Pellobunus insularis* Banks, lateral view of eye tubercle of type.
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CHINESE DRAGONFLIES (ODONATA) IN THE AMERICAN MUSEUM OF NATURAL HISTORY

BY ELSIE BROUGHTON KLOTS¹

"A manual of Chinese dragonflies" by James G. Needham (1930) lists 88 genera and 266 species from China. Subsequent papers by him and by others have increased that list to close to 100 genera and well over 300 species.

In the American Museum of Natural History there are 28 genera and 35 species from China, of which only a portion were examined by Needham in the preparation of his "Manual."

Those studied and listed by him are: *Anotogaster kuchenbeiseri* Foerster, *Ictinus rapax* (Rambur), *Onychogomphus ludens* Needham (holotype), *Anax immaculifrons* Rambur, *Anax guttatus* (Burmeister), *Cephalaeschna acutifrons* Martin, *Diplacodes trivialis* (Rambur), *Diplacodes nebulosa* (Fabricius), *Orthetrum glaucum* (Brauer), *Orthetrum lineostigma* (Selys), *Neurothemis tullia* (Drury), *Sympetrum frequens* (Selys), *Trithemis aurora* (Burmeister), *Vestalis virens* Needham (holotype and allotype), *Rhinocypha drusilla* Needham (allotype), *Rhinocypha perforata* (Percheron), *Megalestes heros* Needham (paratype), *Lestes praemorsa* (Selys), *Platynemis annulata* (Selys), *Aciagrion hisopa* (Selys), and *Indoneura dolorosa* Needham (paratype).

This paper deals with those specimens which are not listed in the "Manual." It describes one new species and three neallotypes; it suppresses two species; and it adds to the distributional range of many more.

ANISOPTERA

Chlorogomphus tunti Needham

Figures 1, 2, 5, 6, 9, 10

Chlorogomphus tunti NEEDHAM, 1930, Zool. Sinica, ser. A, vol. 11, pp. 97-98.

This species was described by Needham from a single female collected in Kwanhsien,

August 11, 1928. A single male in the American Museum has been compared with the type and is almost certainly the same species.

NEALLOTYPIC MALE: Length of abdomen, including appendages, 68 mm.; appendages 3.3 mm.; hind wing 50 mm.; stigma of forewing 3.5 mm., of hind wing 4.5 mm. Width of hind wing at level of arculus 15.5 mm., at level of nodus 13 mm.

Head with eyes very narrowly separated. Labium yellow, fringed with long golden hair and with a brownish spot on either side of the median lobe; remaining mouthparts black with long, sparse, golden hair. Clypeus yellow, with a broad black band across the anteclypeus widened at the lateral margins to include the entire width of the sclerite, and with a narrow black hair line on the clypeal suture. Frons black with a bow-shaped yellow band across its crest and with a round depression covering each lateral third of the anterior surface; top of frons with long black hair. Vertex prominent, erect, and black; antennae black with a yellow ring at the base of the second segment. Triangular occiput black, elevated in the center to form a three-armed ridge and with a long erect fringe of black hair across its rear border. Rear of eyes black.

Prothorax black; anterior lobe elevated with its anterior crest margined with yellow; median lobe large, fringed with long black hair on its lateral margins; posterior lobe narrowly margined with yellow on the sides and fringed with long golden hair.

Synthorax mainly black. The black of the middorsal triangle continuous above and below with the broad antehumeral stripe, leaving a narrow yellow stripe between them; this yellow stripe club-shaped above and pointed to rearward. The black

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antehumeral connected above and below, by way of the black sinus and the black anterior half of the mesinfraepisternum, with the first lateral black stripe. This lateral stripe extends from just before the humeral suture to the level of the anterior edge of the spiracle and is marked with a small yellow spot just below the alar carina. First lateral stripe connected with the second black stripe by way of the alar carina above and the black anterior half of the metinfraepisternum below. Second lateral stripe slightly overrunning the suture in front and covering the metepimeron except for a small median yellow spot beneath the alar carina and a small yellow spot on the posterior corner which runs down on the ventral margin. Spiracle black-rimmed.

Legs black; coxae with yellow spots; anterior femora yellow on the inner side. Wings hyaline, costa and stigma black. Basal subcostal cross vein present; 23 antenodal cross veins and 13 postnodals in the forewing; 18 antenodals and 17 postnodals in the hind wing; the first and the eighth antenodals thickened; stigma of forewing surmounting three or four cross veins; one cross vein in the median space of the forewing, two in the hind; seven cross veins in the cubital space of the forewing, five in the hind; triangles with one cross vein, supratrangles with two or three; 11 cross veins before the median fork in the forewing, seven in the hind; discoidal field with two cell rows to the level of the median fork; anal triangle three-celled; anal loop of eight cells; a single row of cells between Cu_1 and A_1 of the hind wing.

Abdominal segment 1 black with a marginal yellow band across the apex of the dorsum and a large yellow spot on each side narrowly separated from the ventral margins. Segment 2 with sides, including the auricles, yellow, the yellow extending up to encircle the segment with a narrow ring around the median carina and a wider ring at the apex. This apical band is invaded on the middorsal line by the black of the divided shield-like spot of the dorsum. The carinae of segment 2 are black, and there is

also a small black spot on the ventral margin before the median carina and another before the apical. Basal half of segment 2 clothed with long, silky, black hair. Segment 3 with a pair of apical twin spots which meet on the middorsal line. Segments 4 to 6 with these same apical spots, reduced to narrow bands on 5 and 6 but widened on 7 to form an apical band one-fourth the segment length dorsally and one-third the segment length ventrally. Segments 8 and 9 black. Segment 10 black with a small middorsal pale spot. Appendages black; the superiors a little more than one-half as long as the inferiors and divided to almost one-half their length, the arms diverging at an angle of at least 80 degrees. Segments 4 and 5 covered with minute blunt spines, the apical fifth of segment 4 and a ring encircling the segment corresponding in position with the median carina, clear. These same spines are present on segments 5 and 6 and on the middorsal line on the basal part of 7.

TYPE MATERIAL: Neallotype, male, Mt. Omei, Szechwan Province, July, 1938 (Dean Sage, Jr.).

This male differs from the male of *nasutus* Needham in lacking the frontal prominence, in having the enlarged apical yellow ring on abdominal segment 7 instead of on segment 6, and in the greater length of the inferior appendage. The camera lucida sketches which I made of the appendages of *nasutus* several years ago show the inferior appendages in that species to be scarcely longer than the superiors, the angle of divarication of the two branches of the superiors not so great as in this species and the outer lobe of the superiors proportionately smaller. This species belongs to Fraser's Group III, *Orogomphus*, and in his key (Fraser, 1929, p. 142) resembles *atkinsoni* Selys in having only the antehumeral and the two lateral pale stripes, and differs from it in having the face black marked with yellow. It runs out to *dyak* Laidlaw on the presence of the basal subcostal cross vein and differs from it by its larger size (*dyak* hind wing is 38 mm.), the absence of the pale mesothoracic collar, and the structure of the anal appendages.

***Chlorogomphus nasutus* Needham**

Figures 3, 4, 7, 8

Chlorogomphus nasutus NEEDHAM, 1930, Zool. Sinica, ser. A, vol. 11, p. 97.

When I first studied the holotype male of *Chlorogomphus nasutus* and the holotype female of *C. tunti* Needham in the Cornell University collection, I was of the opinion that additional material might prove them to be a single species and that the pyramidal prominence on the front of the frons of *nasutus* and the color markings of abdominal segments 6 and 7 would be found to be sexual characters. The male described above as *tunti* has disproved that belief, however, so it is a little disconcerting to find a female with the same date and locality label as this male and yet resembling the male of *nasutus* in color pattern but lacking the frontal prominence. Although apparently flying with the male of *tunti*¹ and although captured some distance from the type locality of *nasutus*, I ascribe it to the latter species on supposition.

NEALLOTYPE FEMALE: Length of abdomen, including appendages, 75 mm.²; hind wing 60 mm.; stigma of forewing 5 mm., of hind wing 5.4 mm.; width of hind wing at level of arculus 17 mm., at level of nodus 18.5 mm.

Labium yellow, median lobe crossed and bordered with brown. Face covered with stout black bristles. Labrum and anteclypeus black with a narrow yellow band on the intervening suture; postclypeus yellowish with a narrow black anterior border. Frons black with a small, bow-shaped yellow band across its summit, tapering at both ends and not meeting the lateral margins. Front of frons with a slight median swelling caused by the presence of a round depression each side. Vertex swollen behind the ocelli, erect and bilobed, black. The ocelli narrowly ringed with yellow. Occiput black, swollen anteriorly in a triangular ridge.

Prothorax black, anterior lobe with anterior margin yellow; median lobe fringed

with long black hair; posterior lobe with a pair of yellow spots.

Synthorax black, the dorsal yellow stripes narrow, clubbed above and tapering below, widely separated from the curving antehumerals which are narrow and parallel-sided above, wider below where they touch the humeral suture and then curve slightly forward. Sides black, a minute yellow spot at the center of the mesepimeron just under the alar carina, a broad yellow stripe on the first lateral suture extending below the spiracle and then narrowed abruptly to follow the curve of the anterior margin of the metinfraepisternum, a yellow spot on the metepimeron just below the carina, and an elongate spot along the posterior margin. There is a small yellow spot on the rear of each of the three infraepisterna, a yellow spot on all coxae and trochanters. The bases of the femora are pale. Wings enfumed with yellow; costa and stigma black. Basal subcostal cross vein present; 23 antenodal cross veins and 14-15 postnodals in the forewing; 17-19 antenodals and 16-17 postnodals in the hind wing; the first and the seventh or eighth thickened in the forewing and the ninth thickened in the hind wing; stigma of forewing surmounting four cross veins; two cross veins in the median space of both wings; hind wing triangle of three cells; nine cross veins in the cubital space of each wing; six cross veins in the supratrangles; 17 cross veins before the median fork, 11 in the hind wing; forewing discoidal field divides into three cell rows three cells before the median fork; anal loop of 12 cells; two rows of cells between Cu₂ and A₁ of the hind wing.

Abdominal segment 1 black with triangular yellow spots on the sides; segment 2 with this lateral yellow spot extending up along the median carina to form a median ring, and with an apical yellow ring; ventral margins of this segment covered with short black bristles; segment 3 with yellow ventral margins wider at the median carina and separated from the apical yellow ring which is interrupted on the middorsum; segment 4 with yellow ventral carina and an apical ring interrupted ventrally; segment 6 with apical band of yellow almost

¹ Actually, I know only that the locality labels are the same and that both are dated July, 1938.

² Segment 5 is missing; the rest of the abdomen measures 63.5 mm., and the missing segment has been estimated to be about 12 mm. in length.

interrupted on the middorsal line, one-fourth the segment length laterally; segments 7-8 with a small lateroventral apical pale spot; 9-10 and appendages black. Segment 10 is prolonged ventrally.

TYPE MATERIAL: Neallotype, female, Mt. Omei, Szechwan Province, July 12, 1923 (Dean Sage, Jr.).

Anotogaster sieboldii (Selys)

Cordulegaster sieboldii SELYS, 1854, Bull. Acad. Roy. Belgique, ser. 2, vol. 21, p. 107; 1858, Mem. Cour. Soc. Roy. Sci. Liège, vol. 11, p. 605; 1869, Bull. Acad. Roy. Belgique, ser. 2, vol. 28, p. 202.

Anotogaster sieboldii SELYS, 1883, Ann. Soc. Ent. Belgique, vol. 27, pp. 115-116; FRASER, 1929, Mem. Indian Mus., vol. 9, p. 92, fig. 8, pl. 10, fig. 10.

Anotogaster kuchenbeiseri FOERSTER, 1899, Ann. Soc. Ent. Belgique, vol. 43, pp. 68-69; LIU, 1929, Peking Soc. Nat. Hist. Bull., vol. 3, p. 10; NEEDHAM, 1930, Zool. Sinica, ser. A, vol. 11, p. 103.

Three males, one of which was seen by Needham and listed in the "Manual" as *A. kuchenbeiseri* Foerster, run out in Needham's key to that species. Two females, which bear the same date and locality labels as two of the males, run out to *sieboldii* because of their greater size.

	HIND WING	ABDOMEN
Yenping ♂	52 mm.	66 mm.
Mt. Omei ♂	51	63
Hinghwa ♂	54	68
Yenping ♀	62	78
Hinghwa ♀	62	78

The three males have an apical pale spot on the lateral margin of abdominal segment 2, and the Mt. Omei male has, in addition, a narrow apical ring on segment 2 and apical lunules on segment 3. The Hinghwa female has a small spot in the black in front of the upper end of the second lateral suture of the thorax. The variations in the males are the same as those noted by Fraser (1929) in Foerster's *kuchenbeiseri*. This material supports Fraser's conclusions regarding the synonymy of the two species.

LOCALITY RECORDS: *Szechwan Province*: Yenping, male, female, Aug. 11, 1917 (Harry R. Caldwell); Mt. Omei, male, Aug. 13, 1938 (Dean Sage, Jr.). *Fukien Province*: Hinghwa, male, female, July-Aug. (W. B. Cole).

Cordulegaster luniferous Selys

Figures 25-29

Cordulegaster luniferous SELYS, 1878, Bull. Acad. Roy. Belgique, ser. 2, vol. 46, p. 691; McLACHLAN, 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 17, p. 364; NEEDHAM, 1930, Zool. Sinica, ser. A, vol. 11, p. 106.

Cordulegaster pekinensis SELYS, 1886, Compt. Rendus Soc. Ent. Belgique, ser. 3, no. 78, in Ann. Soc. Ent. Belgique, vol. 30, p. 182; McLACHLAN, 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 17, p. 364; NEEDHAM, 1930, Zool. Sinica, ser. A, vol. 11, p. 105.

Cordulegaster luniferous luniferous FRASER, 1929, Mem. Indian Mus., vol. 9, p. 121, pl. 10, fig. 14.

Cordulegaster luniferous pekinensis FRASER, 1929, Mem. Indian Mus., vol. 9, p. 123, pl. 10, fig. 12.

Three specimens from Yunnan differ from Fraser's description (1929) of *luniferous luniferous* Selys in that the labrum is not bordered and crossed with black; the frons does not have a triangular blackish brown spot above but is all yellow; the prothorax is not all black but is marked with yellow; and the anal loop is of five cells. In abdominal color pattern they more closely resemble *luniferous luniferous* Selys than they do *luniferous pekinensis* Selys from which latter named variety they also differ in having a pale rather than a black occiput. The appendages show extraordinary resemblance to those of *Allogaster annandalei* (Fraser) as figured by him (1923, p. 451, as *Anotogaster*). The frons is not so high, nor is the face so broad, as in *Allogaster*.

MALE: Length of abdomen, including appendages, 0.52 mm.; appendages 2.2 mm.; hind wing 39 mm.; stigma of forewing 3 mm., of hind wing 3.8 mm.

Labium yellow, hairy. Labrum yellow, slightly more orange along the anterior border and in the median basal depression. Anteclypeus with its anterior vertical third yellow, its upper swollen two-thirds brown. Postclypeus and front of frons bright orange yellow, fringed along the sides with black hairs. Frons in front flat and cross-ridged, rising to a high sharp ridge and then sloping abruptly down to rearward; not perceptibly higher than the occiput and not much broader than the postclypeus; front surface entirely surrounded by a yellow ridge, top covered with a thick

coat of black hair; sides hairy, slightly more olivaceous. Vertex dark brownish (in one specimen black); antennae black. Occiput orange yellow, more or less horizontal in plane but rising to a triangular ridge which bears a clump of blackish brown hairs at its anterior angle, fringed with black across the rear border. Rear of occiput yellow with brown mottling.

Prothorax with anterior lobe pale brown, bordered anteriorly with black and with a darker brown median spot; median lobe pale brown, darker on the anterior border, black in the middle and on the posterolateral margins; posterior lobe black with a pair of bright yellow spots on the dorsum.

Thorax black marked with bright yellow as follows: triangles on either side of the

spot on the anterior border; metinfraepisternum black, suture broadly brown.

Legs black; femora of the hind pair brown basally and with distal brown stripes; coxae, trochanters, and femora hairy. Wings hyaline, bases golden yellow to a little beyond the first antenodal cross vein and three-fourths of the way to the arculus. Veins brown; subcosta, arculus, and nodus yellow. Discoidal triangles crossed; three cubito-anal cross veins; anal loop of five cells; anal triangle of four cells.

Abdomen with segment 1 brown; paler basally and darker apically and with a thick coat of long golden hair obscuring the pattern. Segment 2 black above with widely separated dorsal twin spots of yellow

	<i>luniferous</i>	<i>pekinensis</i>	Yunnan males	<i>annandalei</i>
Hind wing	39-41 mm.	42 mm.	39 mm.	44 mm.
Labrum	Crossed and bordered with black	Crossed and bordered with black	All yellow	Bordered with black and with median prolongation of black
Frons	Triangular black spot above	Black basal band	All yellow	Darker above
Occiput	Obscurely yellow	Black	Orange yellow	Yellow
Prothorax	Black	Black	Black marked with yellow	Black marked with yellow
Anal loop	7-10 cells	5 cells	5 cells	5 cells
Black lateral stripe of thorax	Occasionally with yellow spots	No spots	Spotted	Spotted
Distribution	Tibet (Moupin) ¹	Peking and Szechwan	Yunnan	Yunnan

dorsum, wider above and with outer sides nearly straight; a faint line in the depression of the upper half of the humeral suture; a broad band on the first lateral suture, not reaching the carina above and extending on the mesepimeron almost to the mesinfraepisternum, on the metepisternum ending abruptly above the spiracle; a small superior spot separated from a short narrow line below it on the center of the black of the metepisternum and followed by two minute dots, one above and one below the spiracle; a faint line in the depths of the depression of the upper two-thirds of the second lateral suture; a broad oval band on the metepimeron. Mesinfraepisternum black with a small bright yellow

just beyond the depressed median carina, and with dorsal apical twin spots, pointed basally; brown below with a yellow longitudinal band extending the length of the sides and covering the rounded auricles, interrupted at the median carina; ventral apical brown part not hairy; minute black spines along the apical carina; intersegmental membrane black. Segment 3 with the same two pairs of dorsal twin spots and with ventral margin yellowish brown, paler before the median carina; intersegmental membrane brownish. Segments 4 to 6 with the same four spots smaller, especially the apical pair; ventral margin of segment 6 slightly expanded. Segment 7 with the median pair of spots small and the apical pair mere pin pricks. Segment 8 with the

¹ Possibly Mupin Szechwan.

median pair of spots very bright yellow; with a lateral band along the ventral margin, expanded basally and apically. Segment 9 with the median spots more basad in position, wider and shorter, the lateral brown band covering most of the sides; region beyond the apical carina black with light markings. Segment 10 without the longitudinal middorsal carina; with an apical yellow spot each side of the dorsum and with a lateral ventral brownish band which is shining and smooth on its basal expansion. Superior appendages brownish black, paler basally; inferior appendages pale brown with a black apical superior tooth.

LOCALITY RECORD: *Yunnan Province*: Loutes-chiang, 3 males (Father A. Genestier).

Ictinus fallax Selys

LOCALITY RECORDS: *Szechwan Province*: Chungking, male, July 31, 1919 (A. Warburton Davidson). *Kiangsu Province*: Shanghai.

Ictinus clavatus (Fabricius)

LOCALITY RECORDS: *Szechwan Province*: Chungking, 2 females, July 31 and Aug. 8, 1919 (A. Warburton Davidson).

Onychogomphus ringens Needham

Figures 13-19

Onychogomphus ringens NEEDHAM, 1930, Zool. Sinica, ser. A, vol. 11, p. 40, pl. 5, fig. 9.

A male from Mt. Omei, Szechwan, runs directly to *ridens* in Needham's key (1930, p. 38) because of the black cross stripe on the labrum, but its appendages agree with the figure of *ringens*. Since the female accompanying it does not have the cross stripe I think there is no doubt but that they are the latter species and that the color of the labrum is variable. The male also differs from the description of the type of *ringens* in that the spots on the sides of segments 8 and 9 are not smallish but are at least one-third of the segment's length, and that the superior appendages are all black.

NEALLOTYPE FEMALE: Length of hind wing 42 mm.; of abdomen 49.5 mm.; of stigma 5.5 mm.

Labium yellow; labrum bright orange yellow with a black anterior border and a fine black line on the clypeal suture; an-

terior clypeus yellow, black on its horizontal surface and in the lateral thirds of the suture; genae and bases of mandibles yellow; postclypeus black with a large yellow spot on the upper lateral corners; frons black with a yellow band across the bilobed crest, wider on the top than on the front but covering two-thirds of the front surface of the frons and punctuated with 10-12 black points towards the side of each bow-shaped crest; vertex black with a small yellow spot behind the ocellary ridge; ocelli yellow-ringed; antennae black with an apical yellow ring on the basal segment; occiput black with a trilobed median yellow spot continuous with the yellow of the rear and with an erect occipital horn on each side of the spot.

Prothorax black, marked with yellow as follows: a band across the anterior border of the erect anterior lobe, widened to form a spot on the median line; twin spots on the middorsal line of the median lobe and a large spot on each posterior lateral corner; a small triangular spot on the middle of the posterior border of the posterior lobe.

Dorsum of thorax black; median carina as far as the fork broadly yellow, the yellow continuous with the broad mesothoracic collar which has two minute black spots at the lower end of the carina; a pair of broad oblique yellow bands, isolated, divergent below; a small isolated spot above and a narrow curved line below just in front of the humeral suture. The black of the humeral suture is continuous below with the broad black band which covers the region between the two lateral sutures and over-spreads the second; three isolated spots occur in this black, the lowermost one quite small. Mesinfraepisternum and metinfraepisternum each with a posterior yellow spot.

Legs black; coxae and all femora broadly streaked with yellow.

Abdomen black, marked with yellow as follows: segment 1 with a middorsal spot and a broad ventral band along the sides; segment 2 with a middorsal spot extending three-fourths the segment length and with a broad lateral band not reaching the apical margin; segment 3 with twin spots fused on the median line and extending almost

to the median carina; these twin spots extend one-third the segment length on 4, one-fourth the segment length on segments 5 and 6 and more than one-half the segment length on 7. Segments 8 and 9 are black with minute lateral basal spots. Segment 10 black with a trilobed yellow spot extending across its width. Appendages yellow, tipped with brown.

This female differs from the type male in that the labrum is not crossed with black; the postclypeal spots are larger; the black band across the base of the frons is only half as wide; there is a yellow spot on the vertex and on the occiput; there is a pair of occipital horns; the yellow on the middorsal carina of the thorax extends its full length; the mesothoracic collar is complete and wider; the lateral yellow spots on abdominal segments 8 and 9 are smaller.

TYPE MATERIAL: Neallotype, female, Mt. Omei, Szechwan Province, July 17, 1938 (Dean Sage, Jr.).

Anisogomphus flavifacies, new species

Figures 20-24

HOLOTYPE MALE: Length of abdomen 41.5 mm.; hind wing 33 mm.; stigma 2.8 mm.

Labium yellow, median lobe broadly bordered and crossed with black. Labrum yellow with a minute impressed black dot at each lateral corner of the suture. Face all yellow. Frons gently swollen, concave above with a slight indentation on the median line, and with a black stripe across its base. Vertex black, flat; antennae black with an apical yellow ring on the first segment. Occiput flat, yellow, with a fringe of black hair, narrowly bordered with black along the anterior border and next the eyes.

Prothorax black, anterior lobe with a large yellow spot across its margin; median lobe with pale dorsal spots fused on the median line and with a large round spot on each of the shoulders; posterior lobe with a wide middorsal yellow spot; proinfraepisternum with two raised yellow spots just above each coxa.

Dorsum of thorax black, the black extending beyond the humeral suture and in a narrow line down across the lower end of

the mesepimeron, marked with yellow as follows: a small spot on the middorsal carina near its upper end, a V-shaped spot in the middle of the membrane within the crest; a pair of wide dorsal bands turned sharply to rearward at their upper ends along the line of the crest and broadly fused with the yellow collar below, the yellow of the collar narrowly interrupted on the median line; a small round spot in the depths of the humeral suture near its upper end; a narrow antehumeral band, incomplete above and at its upper end curved towards the tip of the dorsal band; a spot across the posterior half of the mesinfraepisternum. Sides of the thorax yellow, a black hair line on the lower end of the first lateral suture to just below the level of the black-rimmed spiracle; a narrow black band along the second lateral suture, continuous with the black dorsal carina above and the narrow black line across the coxa below, interrupted near its upper end.

Legs mainly black; coxae yellow with small irregular black markings; trochanter of hind leg with two external spots in line with a yellow spot and an obscure pale line on the outside of the third femora; first femora with a broad yellow band on the outside; second femora with a small yellow spot on the outside near the base; third femora with minute scattered spines and with five large, widely spaced ones on the apical half of the outer row. Wings hyaline with black veins. Stigma dorsally light yellowish brown, ventrally pale golden yellow, darker in the center. Costa yellow on its anterior margin. Basal subcostal cross vein present in all wings. Antenodals 15 in the forewing (14 and 16 in the paratypes), 10 in the hind wing (11 in the paratypes); postnodals 10-11 in the forewing (13 in the paratypes) and 10-11 in the hind wing. Arculus rising at or beyond the second antenodal cross vein, sectors widely separated. Median fork symmetrical; two or more median cross veins in the forewing; A_2 in the hind wing rising under the subtriangle; anal loop of two cells (three or four cells in the paratypes); anal triangle of hind wing of three cells (four and five cells in the paratypes); three to four rows of cells behind Cu_2 in the forewing; five to

six rows along the outer margin of A_1 in the hind wing; A_1 of hind wing with several sectors.

Abdomen mostly black, marked with yellow. Segment 1 yellow with a longitudinal black band on either side of the dorsum and with a thick furry clump of black and silver hair situated in this black; segment 2 yellow with the same two black bands on either side of the dorsum, meeting narrowly across the apex to enclose a long trilobed yellow spot on the middorsal line, and extending down on either side along the apical margin; segment 3 black with a narrow middorsal yellow band which nearly reaches the apex of the segment, a narrow yellow band each side interrupted at the median carina, and a narrow yellow line along the ventral margin; segments 4 to 7 with the narrow middorsal yellow band, interrupted by the black apical carina on 4 to 6, expanding beyond the apical carina on 7 to make a narrow transverse yellow spot; segments 4 to 7 with a basal and a median lateroventral spot, on 7 the median one enlarged and extending basally almost to the basal spot; segments 8 to 10 with a broad yellow spot the full length of each segment, covering the ventral margin and nearly one-half the sides of each segment, 8 and 9 bright yellow beyond the apical carina; segment 10 with small yellow apical twin spots on the dorsum. Appendages black. Hamule of the genitalia of the second segment roughly T-shaped and conspicuously patterned in brown and yellow.

ALLOTYPE FEMALE: Length of abdomen 37 mm.; hind wing 36 mm. Similar to the male; differs as follows: abdominal segment 4 has the median lateral spot extending to almost the full length of the segment but remaining narrow and sinuate; segment 8 and 9 on the sternum conspicuously bright orange marked with brown as in figure 21; vulvar scale bifid. Anal loop of three cells.

TYPE MATERIAL: Holotype male, allotype female, three male paratypes, female paratype, Louteschang, Yunnan Province (Father A. Genestier).

This species seems to differ from all other species of the genus, except *A. pile* Navás, by having an all yellow face. From *A.*

pile it seems to differ in the color pattern of the abdomen and the color of the appendages.

Gomphus scissus McLachlan

Figures 11, 12

Gomphus scissus McLACHLAN, 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 17, p. 367.

Gomphus scissus NEEDHAM, 1930, Zool. Sinica, ser. A, vol. 11, p. 62.

A single female specimen from Mupin, Szechwan, shows a remarkable resemblance to the description of *Gomphus edax* Needham but differs from it in the presence of a median occipital horn, a bright yellow spot on the rear of the occiput, and the greater approximation of the two lobes of the vulvar scale. Doctor Needham writes me that a line of text has been omitted from the original description of *edax* and that the third sentence of that description should read: "The top of the head is black with a V-shaped ridge upon the middle of the vertex and a stout erect black horn on the low occipital border, with a thin fringe of black hairs on either side."¹

Needham was not familiar with McLachlan's species *scissus*, knowing it only from the original description which he transcribed for use in his "Manual." I have not seen *scissus* either, but I am convinced that the specimen before me now is that species and I am inclined to believe that *edax* may also prove to be the same, although the vulvar scale of this specimen, perfectly described by McLachlan, is scarcely reconcilable with that figured for *edax*. An examination of the McLachlan description shows that the yellow spots on the occiput, a character used by Needham in his key, are on the rear of the occiput and that the face is all black. The yellow at the corners of the mouth no doubt refers to the yellow on the bases of the mandibles. The apparent differences in color pattern of the thorax in *scissus* and *edax* are due, I think, to a misinterpretation of McLachlan's description. He describes the yellow collar and crest and then says "behind these is an oblique band on either side of the dorsal crest and a small isolated spot

¹ The italicized words are those omitted from the original text.

below each band placed more outwardly." I rather think he was holding his specimen upside down and was referring to the spots which I describe below as being the small, antehumeral superior spots. McLachlan also refers to a line on the interalar suture. Needham interprets that as corresponding to his second lateral suture and so describes the sides as yellow with a black line on the middle suture. I think McLachlan's interalar suture is the same as Needham's third lateral and that the black stripe is placed as in *edax*.

FEMALE: Length of abdomen 39.5 mm., hind wing 35 mm., stigma of forewing 3.5 mm.

Lips and face shining black, a brown area on the center of the anteclypeus, a broad yellow band across the top of the frons, and a bright yellow spot at the base of each mandible. Base of frons black; vertex black; antennae black with a broad apical yellow ring on the first segment. Occiput black with a broad yellow spot across the back, rising to a point at the rear of the median horn; median occipital horn rising from the anterior face of the occiput.

Prothorax black; anterior lobe with anterior margin broadly yellow; median lobe with median twin spots of yellow separated by a hair line of black, a large yellow spot on each lateral margin, and a small yellow spot in the front of each lateral black area; posterior lobe obscurely yellow across the dorsum of the posterior border.

Dorsum of thorax black, marked with yellow as follows: a very fine line on the crest, a mesothoracic collar separated at the median carina a pair of dorsal stripes divergent downward and isolated, a small antehumeral superior spot on each side. Sides of thorax yellow, the black of the dorsum overspreading the humeral suture and connected above and below with the black stripe on the second lateral suture (Needham's third) and with the widely interrupted stripe on the first lateral suture. This black on the first lateral suture extends a little above the spiracle and includes it. Mesinfraepisternum and metinfraepisternum black with a large yellow spot on their ventral posterior margins.

Coxae and legs black. Wings enfumed;

costa and veins black; stigma dark brown. Basal subcostal cross vein in one wing; 14 antenodals and 11 postnodals in the forewing; anal loop of two cells.

Abdomen black, marked with yellow as follows: a middorsal band, narrow on the base of segment 1 and then expanded to form a wide dorsal spot which is continued in an apical half ring; on segment 2 narrower, trilobed; on segment 3 narrow on the basal fourth and then continued as a hair line along the middorsal carina; on segment 4 forming a narrow basal triangle covering one-fourth of the segment length, continuing in a middorsal hair line, slightly wider on the apical third; on segments 5 to 7 the same basal triangle and middorsal hair line; segments 8 to 10 all black, the intersegmental membranes of 8 and 9 pale. A lateral yellow band covers the sides of segments 1 and 2 to the ventral margin; on 3 narrower, not reaching the margin, interrupted at the median carina and extending only three-fourths of the segment length. Ventral carinae of 8 and 9 yellow. Appendages black with a yellow dorsal spot.

LOCALITY RECORD: *Szechwan Province:* Mupin, female, Aug. 19, 1938 (Dean Sage, Jr.).

Anax parthenope Selys

These specimens all have the hind wing well over 50 mm. in length and therefore do not run out in Needham's key to this species.

LOCALITY RECORDS: *Szechwan Province:* Chungking, female, Aug. 31, 1919 (A. Warburton Davidson); Wanhien, 3 males, female, Sept. 13, 1921 (Third Asiatic Expedition); Mt. Omei, female, Aug. 14, 1938, (Dean Sage, Jr.). *Yunnan Province:* Kunming, male, Sept. 5, 1945, West Mt. (J. R. Fowler).

Hemianax ephippiger Burmeister

LOCALITY RECORD: *Szechwan Province:* Liangnoku, July 4, 1938 (Dean Sage, Jr.).

Gynacantha subinterrupta Rambur

LOCALITY RECORD: *Szechwan Province:* Chungking, female, Aug. 12, 1919 (A. Warburton Davidson). *Fukien Province:* Yenping, male, female, Sept. 29, 1917 (Harry R. Caldwell).

Planaeschna milnei Selys

LOCALITY RECORD: *Fukien Province:* Yenping, male, Sept. 28, 1917 (Harry R. Caldwell).

Cephalaeschna acutifrons Martin

LOCALITY RECORD: *Fukien Province*: Yenping, 2 females, Aug. 20, 1917 (Harry R. Caldwell).

Cephalaeschna lugubris Martin

This specimen differs from Needham's description and figure, though only slightly. The labrum is shining black except for the anterior yellow border; the front of the frons is shining black except for its anterior yellow border; the occiput is black with two yellow spots. In addition to the yellow triangle at each end of the broad lateral thoracic black band there is an intermediate chain of yellow spots in the black. The tips of the appendages are more sharply hooked downward and the apical third is not so strongly elevated.

LOCALITY RECORD: *Szechwan Province*: Mt. Omei, male, Aug. 15-20, 1938 (Dean Sage, Jr.).

Cephalaeschna magdalena Martin

LOCALITY RECORD: *Szechwan Province*: Mt. Omei, 4 males, female, Aug. 15-20, 1938 (Dean Sage, Jr.).

Aeschna melanictera Selys

LOCALITY RECORD: *Szechwan Province*: Mt. Omei, male, female, Aug. 15-20, 1938 (Dean Sage, Jr.).

Orthetrum albistylum (Selys)

LOCALITY RECORDS: (Series) *Szechwan Province*: Chungking, Aug. 2, 1919 (A. Warburton Davidson); Lushan, Aug. 7, 1938 (Dean Sage, Jr.); Mt. Omei, Aug. 21, 1938 (Dean Sage, Jr.); Wanhhsien, Sept. 28, 1921 (Third Asiatic Expedition); Yachow, Sept. 2, 1938 (Dean Sage, Jr.). *Fukien Province*: Hinghwa, July-Aug. (W. B. Cole); Yenping, Sept. 8, 1917 (Harry R. Caldwell). *Yunnan Province*: Kunming, male, Sept. 5, 1945, West Mt. (J. R. Fowler).

Orthetrum internum McLachlan

LOCALITY RECORD: *Yunnan Province*: Louteschiang, 2 males, female (Father A. Genestier).

Orthetrum lineostigma (Selys)

LOCALITY RECORD: *Fukien Province*: Yenping, male, June 30, 1917 (Harry R. Caldwell).

Orthetrum neglectum (Rambur)

LOCALITY RECORDS: *Szechwan Province*: Yachow, male, Sept. 3, 1938 (Dean Sage, Jr.); Yuitung, 3 males, Aug. 11, 1938 (Dean Sage, Jr.).

Yunnan Province: Louteschiang, 3 males, female (Father A. Genestier).

Orthetrum sabinum (Drury)

LOCALITY RECORDS: *Szechwan Province*: Mt. Omei, 2 males, July 17, 1938 (Dean Sage, Jr.); Wanhhsien, 5 males, Sept. 12-15, 1921 (Third Asiatic Expedition). *Fukien Province*: Fuchow, 9 males, May 5, 1917 (C. R. Kellogg); Yenping, male, female, Aug. 10-17, Sept. 8, 1917 (Harry R. Caldwell).

Orthetrum testaceum (Burmeister)

LOCALITY RECORDS: *Szechwan Province*: Wanhhsien, male, Sept. 15, 1921 (Third Asiatic Expedition). *Fukien Province*: Yenping, 3 males, female, Aug. 14, 1917 (Harry R. Caldwell).

Orthetrum melanium (Selys)

The males from Mupin are smaller than the others, the hind wing measuring, respectively, 35, 36, 37, and 43 mm. The forewing triangles are of three cells, and there are four rows in the discoidal field.

LOCALITY RECORDS: *Szechwan Province*: Mt. Omei, female, Aug. 14, 1938 (Dean Sage, Jr.); Mupin, 2 females, 4 males, July 25-29, 1938 (Dean Sage, Jr.); Yinching, male, Sept. 28, 1938 (Dean Sage, Jr.). *Fukien Province*: Yenping, 3 males, May 29, Aug. 28, Sept. 8, female, July 23 (Harry R. Caldwell). *Kwangtung Province*: Hongkong, male, Sept. 22, 1920, Peak Hotel (H. E. Crampton).

Rhyothemis variegata

Linnaeus and Johansson

LOCALITY RECORDS: (Series) *Fukien Province*: Yenping, Aug. 30, 1917 (Harry R. Caldwell). *Kwangtung Province*: Canton, Sept. 23, 1920 (H. E. Crampton).

Palpopleura sexmaculata Fabricius

LOCALITY RECORDS: *Szechwan Province*: Chungking, Aug. 9, 1919 (A. Warburton Davidson). *Fukien Province*: Hinghwa, 2 males, female, July (W. B. Cole); Yenping, Sept. 8 (W. B. Cole). *Kwangtung Province*: Canton, female, Sept. 22, 1920 (H. E. Crampton).

Crocothemis servilia Drury

LOCALITY RECORDS: (Series) *Szechwan Province*: Wanhhsien, Sept. 13, 1921 (Third Asiatic Expedition); Chungking, Aug. 15, 1919 (A. Warburton Davidson); Yachow, Aug. 14, 1938 (Dean Sage, Jr.); Mt. Omei, July 18, 1938 (Dean Sage, Jr.); Futsing, July 10, 1916 (Roy Chapman Andrews). *Kwangtung Province*: Canton, Sept. 22, 1920 (H. G. Crampton).

Sympetrum croceolum Selys

LOCALITY RECORDS: *Szechwan Province*: Wansien, male, Sept. 15, 1921 (Third Asiatic Expedition). *Fukien Province*: Yenping, female, July 21, 1917 (Harry R. Caldwell).

Sympetrum darwinianum Selys

LOCALITY RECORD: *Szechwan Province*: Wansien, Sept. 13, 1921 (Third Asiatic Expedition).

Sympetrum eroticum ardens McLachlan

LOCALITY RECORDS: (Large series) *Szechwan Province*: Chungking, Aug. 5, 1919 (A. Warburton Davidson); Mt. Omei, Aug. 15-20, 1938 (Dean Sage, Jr.); Wansien, Sept. 14, 1921 (Third Asiatic Expedition); Yinchong, Sept. 1, 1938 (Dean Sage, Jr.). *Fukien Province*: Hinghwa, July-Aug. (W. B. Cole); Yenping, May 25, July-Aug. (Harry R. Caldwell); Fuchow (W. B. Cole).

Neurothemis fulvia Drury

LOCALITY RECORDS: *Fukien Province*: Fuchow, large series, Aug. 17, 1914 (C. R. Kellogg, W. B. Cole).

Pantala flavescens Fabricius

A large series from all localities.

Tramea chinensis DeGeer

LOCALITY RECORDS: *Szechwan Province*: Wansien, male, female, Sept. 22; Chungking, 4 females, Aug. 4-15, 1919 (A. Warburton Davidson); Yinchong, 3 females, Sept. 1, 1938 (Dean Sage, Jr.). *Fukien Province*: Yenping, 3 males, 2 females, Sept. 8-11, 1917 (Harry R. Caldwell).

Tholymis tillarga (Fabricius)

LOCALITY RECORD: Formosa (Souter).

ZYGOPTERA**Agrion atratum (Selys)**

LOCALITY RECORD: *Szechwan Province*: Chungking, large series, Sept. 1-12, 1919 (A. Warburton Davidson).

Agrion oberthurii McLachlan

LOCALITY RECORD: *Szechwan Province*: Lushan, male, July 18, 1938 (Dean Sage, Jr.).

Matrona basillaris Selys

LOCALITY RECORDS: *Szechwan Province*: Tatsienlu, 3 females, July 14, 1938 (Dean Sage, Jr.); Lushan, male, July 8, 1938 (Dean Sage, Jr.); Mt. Omei, male, female, May 25, 1938, male, female, June 23, 1938 (Dean Sage, Jr.);

Yachow, male, female, July 14, 1938 (Dean Sage, Jr.). *Hupei Province*: Ichang Gorge, male, female, June 1921 (Third Asiatic Expedition); Peking, 5 males, 2 females, Aug. 7, 1921 (Third Asiatic Expedition). *Fukien Province*: Fuchow, male (W. B. Cole); Hinghwa, 4 males, 9 females, July-Aug. (W. B. Cole).

Archineura incarnata (Karsch)

The appendages of this specimen differ slightly from the figure in Needham's "Manual" (pl. 16, fig. 1) in that the inferiors from the dorsal aspect become approximated before the superiors.

LOCALITY RECORD: *Szechwan Province*: Lushan, male, July 18, 1938 (Dean Sage, Jr.).

Neurobasis chinensis (Linnaeus)

LOCALITY RECORD: *Fukien Province*: Fuchow, pair (C. R. Kellogg).

Vestalis virens Needham

LOCALITY RECORD: *Szechwan Province*: Taiping, male, female, July 24-25, 1938 (Dean Sage, Jr.).

Pseudophaea decorata (Selys)

LOCALITY RECORD: *Hupei Province*: Ichang Gorge, male, June, 1927.

Bayadera bidentata Needham

LOCALITY RECORD: *Szechwan Province*: Mt. Omei, 2 males, Aug. 20, 1938 (Dean Sage, Jr.).

Rhinocypha perforata (Percheron)

LOCALITY RECORD: *Fukien Province*: Yenping, 2 males, June 14, Sept. 28, 1917 (C. R. Kellogg).

Caliphaea confusa Selys

The inferior appendages of these specimens differ from those shown by Needham (as *C. consimilis*) in that they are broad at the base, slender in the apical third with the tip inturned like a stout crochet hook.

LOCALITY RECORD: *Szechwan Province*: Mt. Omei, 3 males, female, July 15-20, 1938 (Dean Sage, Jr.); Yinchong, male, Sept. 2, 1938 (Dean Sage, Jr.). *Yunnan Province*: Louteschang, large series (Father A. Genestier).

Megalestes distans Needham

Identification of these specimens cannot be certain since the tips of the male abdomens are missing.

LOCALITY RECORD: *Szechwan Province*: Tatsienlu, 2 males, 2 females, July 14, 1938 (Dean Sage, Jr.).

Mesopodagrion tibetanum McLachlan

LOCALITY RECORD: *Yunnan Province*: Loutse-chiang, large series (Father A. Genestier).

Platycnemis annulata Selys

The superior appendages of these specimens have upturned tips.

LOCALITY RECORD: *Szechwan Province*: Mupin, male, July 19, 1938 (Dean Sage, Jr.).

Pyrrhosoma tinctipennis McLachlan

LOCALITY RECORD: *Yunnan Province*: Loutse-chiang, 2 males (Father A. Genestier).

Agriocnemis pygmaea Rambur

LOCALITY RECORD: Formosa (A. Souter).

Agriocnemis femina Brauer

LOCALITY RECORD: *Fukien Province*: Fuchow, 2 males (C. R. Kellogg); Yenping, male, July 20, 1917 (Harry R. Caldwell).

Agriocnemis lacteola Selys

LOCALITY RECORD: *Fukien Province*: Yenping, male, June 20, 1917 (Harry R. Caldwell).

Aciagrion hisopa Selys

LOCALITY RECORDS: *Szechwan Province*: Wanhhsien, 2 males, 2 females, Sept. 15, 1921, 4 males (Third Asiatic Expedition). *Fukien Province*: Fuchow, female, May 5, 1917 (W. B. Cole).

Ceriagrion melanurum Selys

LOCALITY RECORDS: *Szechwan Province*: Chungking, 2 males, Aug. 17, 1919 (A. Warburton Davidson); Faliu, male, Aug. 19, 1921 (Third Asiatic Expedition); Mupin, 4 males, 3 females, July 22-29, 1938 (Dean Sage, Jr.); Tailing, 3 males, female, Aug. 24-25, 1938 (Dean Sage, Jr.); Yachow, male, July 14, 1938 (Dean Sage, Jr.); Wanhhsien, 5 males, Sept. 12-15, 1921 (Third Asiatic Expedition). *Fukien Province*: Hinghwa, 3 males, female, July 7; Yenping, male, July 16, 2 males, Sept. 6-9, 1917 (Harry R. Caldwell); Fuchow, 2 females, May 5, 1917 (W. B. Cole).

Ceriagrion erubescens Selys

LOCALITY RECORD: *Szechwan Province*: Mupin, 3 males, July 25, 1929 (Dean Sage, Jr.).

Coenagrion species

One male, with the tips of the appendages gone, answers the description of *scutleri* Ris except that the fine brown lines in the second and third lateral sutures are extremely abbreviated.

LOCALITY RECORD: *Szechwan Province*: Wanhhsien, male, Sept. 15, 1921 (Third Asiatic Expedition).

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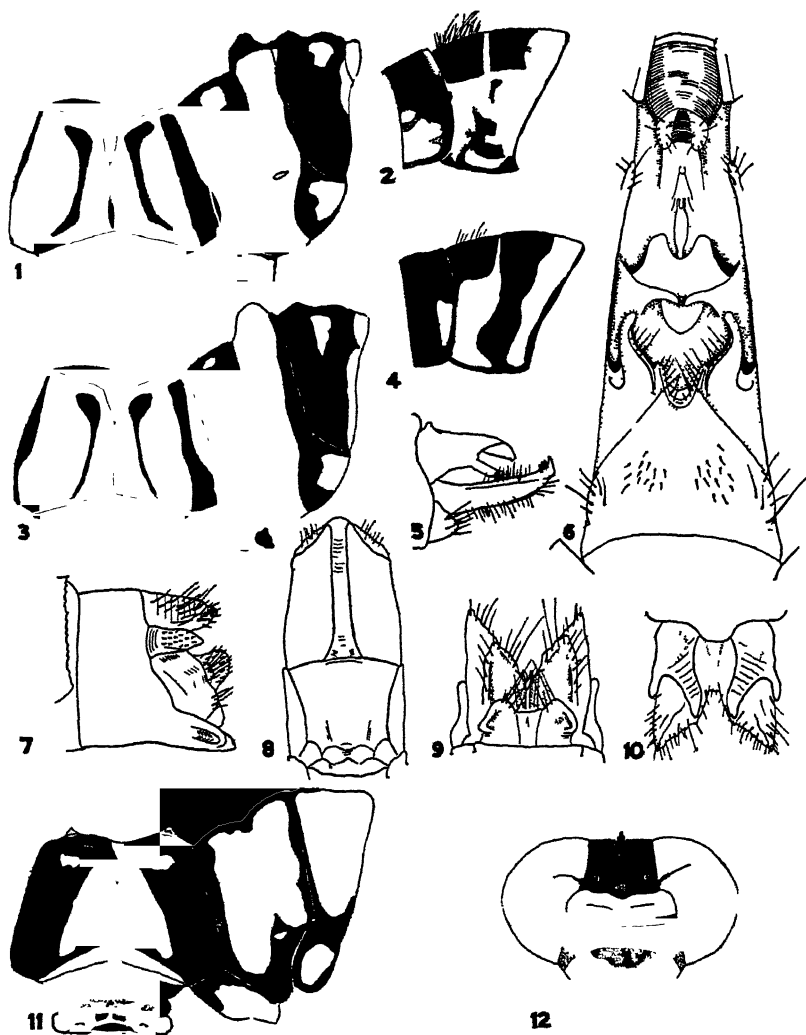
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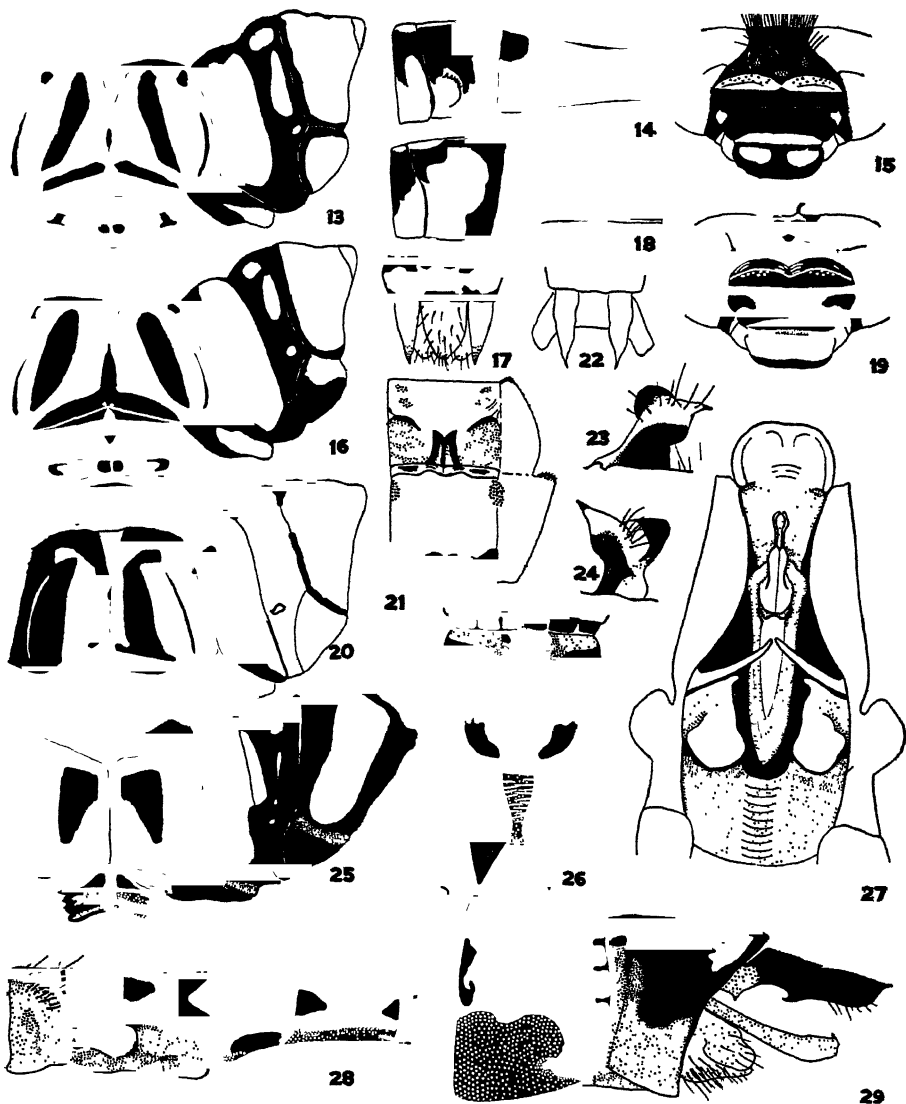
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- Fig. 1. *Chlorogomphus tunti* Needham, male, diagram color pattern, thorax.
 Fig. 2. *Chlorogomphus tunti* Needham, male, diagram color pattern, first two abdominal segments, lateral view.
 Fig. 3. *Chlorogomphus nasutus* Needham, female, diagram color pattern, thorax.
 Fig. 4. *Chlorogomphus nasutus* Needham, female, diagram color pattern, first two abdominal segments, lateral view.
 Fig. 5. *Chlorogomphus tunti* Needham, male, abdominal appendages, lateral view.
 Fig. 6. *Chlorogomphus tunti* Needham, male, genitalia, second segment, ventral view.
 Fig. 7. *Chlorogomphus nasutus* Needham, female, abdominal appendages, lateral view.
 Fig. 8. *Chlorogomphus nasutus* Needham, female, abdominal segments 9-10, ventral view.
 Fig. 9. *Chlorogomphus tunti* Needham, male, abdominal appendages, ventral view.
 Fig. 10. *Chlorogomphus tunti* Needham, male, abdominal appendages, dorsal view.
 Fig. 11. *Gomphus scissus* McLachlan, female, diagram color pattern, thorax.
 Fig. 12. *Gomphus scissus* McLachlan, female, diagram color pattern, face.



- Fig. 13. *Onychogomphus ringens* Needham, male, diagram color pattern, thorax.
 Fig. 14. *Onychogomphus ringens* Needham, male, diagram color pattern, first three abdominal segments, lateral view.
 Fig. 15. *Onychogomphus ringens* Needham, male, diagram color pattern, face.
 Fig. 16. *Onychogomphus ringens* Needham, female, diagram color pattern, thorax.
 Fig. 17. *Onychogomphus ringens* Needham, female, anal appendages, dorsal view.
 Fig. 18. *Onychogomphus ringens* Needham, female, diagram color pattern, first three abdominal segments, lateral view.
 Fig. 19. *Onychogomphus ringens* Needham, female, diagram color pattern, face.
 Fig. 20. *Anisogomphus flavifacies*, new species, male, diagram color pattern, thorax.
 Fig. 21. *Anisogomphus flavifacies*, new species, female, abdominal segments 8-9, ventral view.
 Fig. 22. *Anisogomphus flavifacies*, new species, male, anal appendages, dorsal view.
 Fig. 23. *Anisogomphus flavifacies*, new species, male, hamule, inner view.
 Fig. 24. *Anisogomphus flavifacies*, new species, male, hamule, outer view.
 Fig. 25. *Cordulegaster luniferous* Selys, male, diagram color pattern, thorax.
 Fig. 26. *Cordulegaster luniferous* Selys, male, abdominal segment 10 and anal appendages, dorsal view.
 Fig. 27. *Cordulegaster luniferous* Selys, male, genitalia, second abdominal segment, ventral view.
 Fig. 28. *Cordulegaster luniferous* Selys, male, diagram color pattern, first three abdominal segments, lateral view.
 Fig. 29. *Cordulegaster luniferous* Selys, male, abdominal segments 9-10 and anal appendages, lateral view.

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VARIATION OF TWO CHARACTERS IN *BUFO FOWLERI* AND *BUFO AMERICANUS*

BY ALBERT P. BLAIR¹

In a previous paper (Blair, 1941) it was shown that early-breeding toads at Bloomington, Indiana, have relatively large hind leg warts and narrow interparotoid spaces as compared with late-breeding toads at the same locality, that the change in size of hind leg warts and interparotoid spaces is gradual, and that the early-breeding and late-breeding populations are referable to what is generally considered *Bufo americanus* and *B. fowleri*, respectively. The present paper will be concerned with three seasonal population samples from Oradell, New Jersey, and with individual collections of *B. americanus* and *B. fowleri* from the following localities: Elizabeth Islands, Massachusetts; Wilburton, Oklahoma; Oshkosh, Wisconsin; Polk, Pennsylvania; Utica, New York; Bronx, New York; Leonia, New Jersey; Englewood, New Jersey. Only Fowler's toad occurs on the Elizabeth Islands. At Polk, Oshkosh, and possibly Utica the American toad is the only form. Both the American toad and Fowler's toad occur at Wilburton, Leonia, Englewood, and probably the Bronx. The collection from Wilburton consists of two population samples, each relatively homogeneous, made on different dates, and referable to the two species under consideration. The Bronx, Englewood, and Leonia collections are referable to *B. americanus*. All specimens here considered are adult males.

At Bloomington it was found that by the second week in May the breeding population was relatively homogeneous and referable to *Bufo fowleri*. At Oradell none of the three collections was homogeneous. The May 19 sample was predominantly *americanus*-like, while *B. fowleri* characteristics predominated in the June 13 and June 28

samples. But even the June 28 sample was by no means as homogeneous as the Bloomington sample of May 7, 1940.

Let us examine the Oradell toads with respect to the two characters under consideration (tables 1 and 2). The average hind leg wart size for Oradell toads for May 19 is 2.00 mm., a figure intermediate between the Bloomington averages for April 29 and April 30, at which time the transition from *americanus* to *fowleri* is marked in the Bloomington population. By June 13 the Oradell average drops to 1.65 mm. It is to be noted that the Oradell average changes less in 25 days than the Bloomington average changes from one night to the next. But by June 28 the Oradell average is significantly lower than the May 7 Bloomington average, despite the fact that in general Oradell toads of June 28 are more heterogeneous than Bloomington toads of May 7.

The situation with respect to interparotoid space is quite different. The interparotoid space mean for May 19 Oradell toads does not differ significantly from that of May 7 Bloomington toads, although the May 7 Bloomington population is predominantly *fowleri*-like, while the May 19 Oradell population is predominantly *americanus*-like. No increase of interparotoid space is evident in subsequent collections; in fact, the June 13 and June 28 samples show smaller interparotoid spaces than the first sample.

Both Elizabeth Islands and Wilburton *fowleri* are quite similar to May 7 Bloomington and June 28 Oradell toads (*Bufo fowleri*) with respect to hind leg wart size; only Elizabeth Islands and June 28 Oradell toads differ significantly. But with respect to interparotoid space, Elizabeth Islands

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toads differ significantly from May 7 Bloomington and June 28 Oradell toads, and, in fact, from all other samples. No data are available for interparotoid space of Wilburton *fowleri*.

Among the American toad samples from localities other than Oradell and Bloomington, the largest hind leg warts are found at Polk and Utica; in both localities hind leg warts are much larger than in the earliest Bloomington sample, which is presumably most *americanus*-like. Means for Polk and Utica differ significantly.

ington sample; the difference, however, is not significant with respect to Oshkosh and Wilburton samples. The adjacent Leonia and Englewood samples do not differ significantly, nor do they differ from any of the three samples from nearby Oradell. The Englewood sample does not differ significantly from the Bronx sample; however, the Leonia sample does. The Bronx and Utica samples do not differ significantly.

Certain conclusions may be drawn. In general, adjacent populations tend to resemble one another more closely than they

TABLE 1

MEANS AND STANDARD DEVIATIONS OF THE MEANS FOR HIND LEG WART AND INTERPAROTOID SPACE (MEASUREMENT IN MILLIMETERS)

		Hind Leg Wart		Interparotoid Space	
		N	Mean $\pm$ σ m	N	Mean $\pm$ σ m
Bloomington	April 15, 1940	158	m = 2.57 $\pm$ 0.04	158	m = 7.85 $\pm$ 0.08
	April 29, 1940	243	m = 2.33 $\pm$ 0.03	62	m = 8.46 $\pm$ 0.12
	April 30, 1940	75	m = 1.56 $\pm$ 0.07	17	m = 8.40 $\pm$ 0.25
	May 5, 1940	58	m = 1.76 $\pm$ 0.09		
	May 6, 1940	117	m = 1.75 $\pm$ 0.07		
	May 7, 1940	138	m = 1.34 $\pm$ 0.04	34	m = 9.51 $\pm$ 0.14
	May 7, 1939			162	m = 9.66 $\pm$ 0.11
Oradell	May 19, 1946	33	m = 2.00 $\pm$ 0.13	33	m = 9.45 $\pm$ 0.21
	June 13, 1946	40	m = 1.65 $\pm$ 0.09	40	m = 9.05 $\pm$ 0.15
	June 28, 1946	20	m = 1.18 $\pm$ 0.08	20	m = 9.07 $\pm$ 0.20
<i>fowleri</i>	Elizabeth Islands	13	m = 1.46 $\pm$ 0.08	13	m = 11.16 $\pm$ 0.28
	Wilburton	40	m = 1.39 $\pm$ 0.04		
<i>americanus</i>	Polk	43	m = 3.10 $\pm$ 0.06		
	Oshkosh	51	m = 2.37 $\pm$ 0.05	17	m = 8.29 $\pm$ 0.18
	Utica	29	m = 3.48 $\pm$ 0.10	29	m = 8.56 $\pm$ 0.11
	Bronx	36	m = 2.41 $\pm$ 0.065	36	m = 8.34 $\pm$ 0.13
	Leonia	58	m = 2.56 $\pm$ 0.065	58	m = 9.09 $\pm$ 0.12
	Englewood	17	m = 2.57 $\pm$ 0.08	17	m = 8.61 $\pm$ 0.26
	Wilburton	25	m = 2.21 $\pm$ 0.08	25	m = 8.24 $\pm$ 0.24

The smallest hind leg warts are found in the Wilburton sample; the mean is significantly smaller than the earliest Bloomington mean. Hind leg wart means of approximately equal magnitude are found in the samples from Oshkosh, Bronx, Leonia, and Englewood; these means are comparable with the mean for the earliest Bloomington sample.

The pattern of variation of interparotoid space size in individual American toad samples does not follow that of hind leg wart size. In all samples interparotoid space is larger than in the earliest Bloom-

ington sample. Different characters vary independently. Hybridization presumably has taken place both at Bloomington and Oradell. The temporal ranges of variation, however, are different at these two localities. To what extent such differences are attributable to the extent of hybridization and to what extent to geographical variation is not completely apparent. It is the belief of the writer that hybridization has progressed further at Oradell.

Ultimately, adequate interpretation of such variation data must depend upon reso-

TABLE 2

CRITICAL RATIOS

(The critical ratio is defined as the ratio of the difference between the means to the standard error of the difference between the means; a C.R. of 2.5 or greater is taken as significant.)

Interparotoid Space	Bloomington						Oradell			<i>fowleri</i>			<i>americanus</i>							
	April 15, 1940	April 29, 1940	April 30, 1940	May 5, 1940	May 6, 1940	May 7, 1940	May 7, 1939	May 19, 1946	June 13, 1946	June 28, 1946	Elizabeth Islands	Wilburton	Polk	Oshkosh	Utica	Bronx	Leonia	Englewood	Wilburton	
Hind Leg Wart																				
April 15, 1940	4.8	4.2	2.1	—	—	—	—	7.1	7.1	5.7	11.4	—	—	—	2.2	5.2	3.2	8.6	2.8	1.5
April 29, 1940	12.5	10.0	0.2	—	—	—	—	4.1	3.1	2.6	9.0	—	—	—	0.8	0.6	0.7	3.7	0.5	0.8
April 30, 1940	8.2	6.0	1.8	—	—	—	—	3.2	2.2	2.1	7.3	—	—	—	0.3	0.6	0.2	2.5	0.6	0.5
May 5, 1940	10.2	7.6	1.9	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
May 6, 1940	21.7	19.8	2.7	4.3	5.1	—	—	0.2	2.2	1.8	5.3	—	—	—	5.4	5.2	6.1	2.3	3.1	4.6
May 7, 1940	—	—	—	—	—	—	0.8	0.9	3.3	2.6	5.0	—	—	—	6.5	7.1	7.8	3.5	3.7	5.4
May 7, 1939	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
May 19, 1946	4.2	2.5	3.0	1.5	1.7	4.9	—	—	1.5	1.3	4.9	—	—	—	4.2	3.7	4.5	1.5	2.5	3.8
June 13, 1946	9.3	7.2	0.8	0.9	0.9	3.1	—	2.2	—	0.1	6.6	—	—	—	3.2	2.6	3.6	0.2	1.5	2.9
June 28, 1946	15.5	13.5	3.6	4.8	5.3	1.8	—	5.5	3.9	—	6.1	—	—	—	2.9	2.2	3.1	0.1	1.4	2.6
Elizabeth Islands	12.4	10.2	0.9	2.5	2.7	1.3	—	3.5	1.6	2.5	—	—	—	—	8.6	8.6	9.1	6.8	6.7	7.9
Wilburton	21.1	18.8	2.1	3.8	4.5	0.9	—	4.5	2.6	2.4	0.8	—	—	—	—	—	—	—	—	—
Polk	7.4	11.5	16.7	12.4	14.6	24.4	—	7.6	13.4	19.2	16.4	23.7	—	—	—	—	—	—	—	—
Oshkosh	3.1	0.7	9.4	5.9	7.2	16.1	—	2.7	7.0	12.6	9.6	15.3	9.1	—	—	1.3	3.6	1.0	0.2	—
Utica	8.4	11.0	14.0	12.2	12.6	19.9	—	9.0	12.9	17.9	15.7	19.3	3.3	9.9	—	—	—	—	—	—
Bronx	2.1	1.1	8.9	5.9	6.9	14.1	—	2.8	6.8	11.9	9.2	15.7	7.8	0.5	8.9	—	—	—	—	—
Leonia	0.1	3.2	10.5	7.2	8.5	16.0	—	3.9	8.2	13.4	10.7	18.0	7.1	2.3	7.7	2.3	0.1	1.6	3.2	—
Englewood	0.0	2.8	9.5	6.7	7.7	13.7	—	3.7	7.6	12.3	9.8	13.2	5.3	2.1	6.3	1.5	0.1	1.6	3.2	—
Wilburton	4.0	1.4	6.1	3.7	4.3	9.7	—	1.4	4.7	9.1	6.6	9.2	9.0	1.7	9.9	2.0	3.4	3.2	—	—

lution of two questions. First, what is the nature of genetic control of breeding time? Is the control genetically simple, determining merely that the American toad breeds within a definite temperature range and that Fowler's toad breeds within a different temperature range, with relatively early- or late-breeding toads of a given species being such only because of environmental conditions? Or is the control complex, depending on many genes, with early-breeding Fowler's toads genetically different from late-breeding Fowler's toads? And if so, are hind leg wart and interparotoid space size genes linked to genes for time of breeding?

Second, to what extent has hybridization altered the range of variation in Fowler's toad and the American toad? Wherever the two species occur together some intermediates are found (Blair, 1941). Is this exchange of genes of very recent origin or has it played an important role in the configuration of the species at least from the last glacial recession? The present range of the American toad is from northern Georgia and northeastern Texas on the south to James Bay on the north; the western edge of the range is the eastern boundary of the prairie plains. The Canadian population has been described as a separate subspecies, *B. americanus copei*, but the known specimens are so few and the differences so poorly defined that appraisal of this form is not yet possible. In the northern Great Plains the American toad is replaced by *B. hemiophrys*, an allied form whose range is entirely within glaciated territory. In the southeastern United States the American toad is replaced by the closely allied *B. terrestris*; at the line of juncture of the two forms intermediates are found.

Roughly speaking, Fowler's toad coexists with the American toad over the southern half of the range of the American toad. In the southeast it is, as is the American toad, replaced by *B. terrestris* with intermediates along the line of junction. *Bufo fowleri* does not go so far west or northwest as *B. americanus*. Along the

eastern border of the prairie plains Fowler's toad is replaced, with a varying degree of intergradation, by *Bufo woodhousii*, its closest relative. West of the line of junction lies a narrow north-south strip (at places 100 miles or more wide) where *B. americanus* and *B. woodhousii* coexist; intermediates between these two forms are also present.

The writer has in the past referred to the toads of the lower Mississippi Valley as *B. fowleri*, and this is perhaps the best designation. This population has, however, some of the characteristics of the American toad.

From a number of localities (northern Michigan, northwestern Pennsylvania, upstate New York, the Great Smoky Mountains) the writer has seen collections of large, dark, excessively spiny American toads which are quite distinctive. Do such populations represent ecological segregates, or is it too much to suppose that they constitute the most homogeneous American toad stock and that most so-called American toads are more or less contaminated with genes of the *fowleri-woodhousii* group? The findings of Moore (1944) are suggestive. In an investigation of the embryonic developmental rate of toads in the vicinity of New York City, it was found that *B. fowleri* from Flushing, Long Island, New York, where the American toad does not occur, had a time interval of 107 hours between first cleavage and gill circulation. Toads from Bear Mountain, New York, where the population is "good" *americanus*, showed an interval of 91 hours. Finally, American toads from Tenafly, New Jersey, where there has presumably been considerable hybridization, showed an interval of 98 hours. This is striking confirmation, from a physiological investigation, of morphological taxonomic findings.

In summary, then, morphological characters of Fowler's toad and the American toad vary from locality to locality and from breeding date to breeding date in a given locality. It seems likely that this variability is due both to geographical variation and to hybridization.

ACKNOWLEDGMENT

Mr. C. M. Bogert of the Department of Amphibians and Reptiles made available the animals of the Utica, Bronx, Englewood, and Leonia series, aided in collection of the Oradell series, and read the manuscript.

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NEW TERMITES FROM THE INDO-MALAYAN AND PAPUAN REGIONS

BY MUZAFFER AHMAD¹

The present study, based upon specimens in the collection of Dr. Alfred E. Emerson, deals with six new species. *Hospitalitermes moluccanus* and *H. papuanus* are of particular interest in that the distribution of *Hospitalitermes*, hitherto known only from the Indo-Malayan region, is extended into the Papuan region, as shown in the accompanying map (fig. 2), which was prepared by Miss Laura Churchill under the direction of Dr. Emerson. The type specimens are deposited in the collection of the American Museum of Natural History now in the custody of Dr. Emerson. Paratypes are in the author's collection and also in the United States National Museum, Washington, D. C.

I am greatly indebted to Dr. Emerson for checking my identifications and for suggestions during the preparation of this paper.

Odontotermes (*Cyclotermes*) *paradenticulatus*, new species

Figure 1

SOLDIER: Head light brown; labrum brown; mandibles dark reddish brown; rest of the body creamy white. A few scattered bristles on the head; tip of labrum with long bristles; tergites moderately hairy. Head ovoid, slightly narrowed in front. Left mandible with a small, sharply pointed tooth midway between the center and the tip. Antennae with 16 to 17 articles, the third article shortest. Postmentum broad with more or less parallel sides. Pronotum saddle-shaped, anterior margin emarginate; posterior margin more broadly emarginate; anterolateral sides broadly rounded.

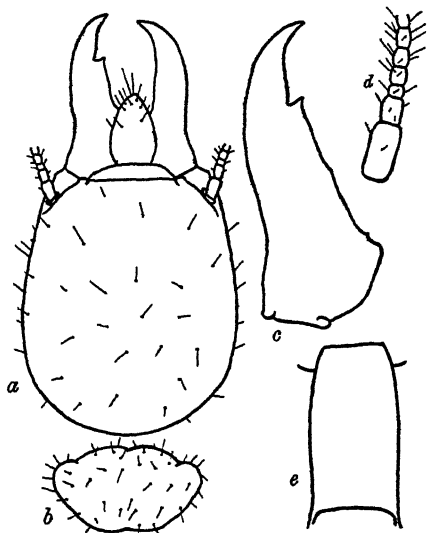


Fig. 1. *Odontotermes* (*Cyclotermes*) *paradenticulatus*, new species. A, Dorsal view of head; B, pronotum; C, left mandible; D, base of antenna; E, postmentum.

COMPARISONS: Agrees with *C. denticulatus* from Sumatra in size, shape, and coloration but can be distinguished from it by the relative position of the tooth on the left mandible (in *denticulatus* the tooth is nearer to the middle than in *paradenticulatus*). *C. formosanus*, a widely distributed species in the Indo-Malayan region, differs in having much more slender mandibles and a very minute marginal tooth on the right mandible.

TYPE LOCALITY: East shore of Lake Bito, west of Tarragona, Leyte, Philippines (124° 55' E. longitude and 10° 40' N. latitude), August 21, 1945, several soldiers, workers, and nymphs (C. L. Remington). "In honeycomb-like nest under a large boulder."

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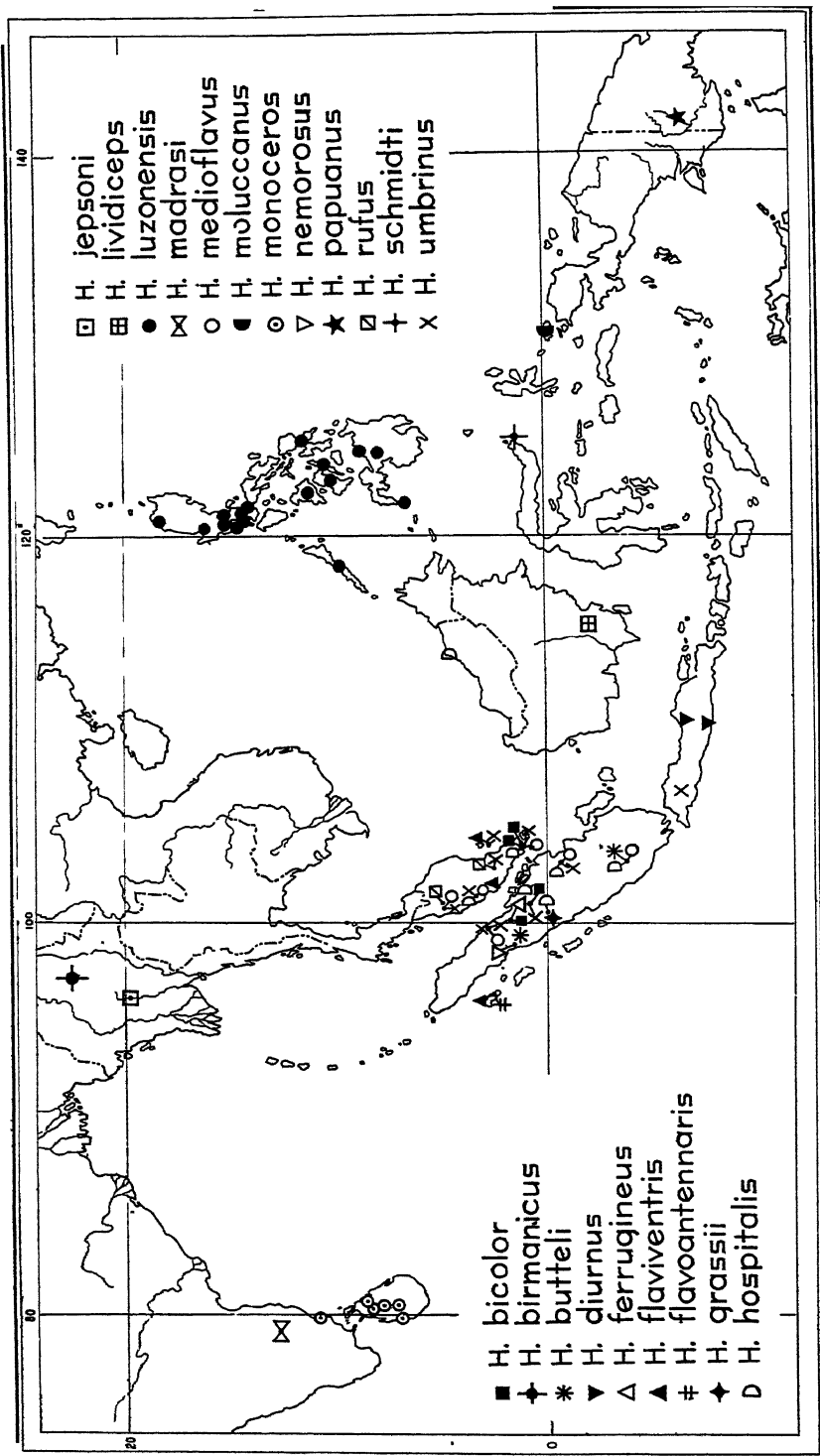


Fig. 2. Geographical distribution of the genus *Hospitalitermes* Holmgren.

MEASUREMENTS (IN MM.)

	No.	RANGE	MEAN
Length of head with mandibles	8	2.22-2.34	2.29
Length of head to side base of mandibles	9	1.35-1.47	1.41
Width of head	9	1.16-1.26	1.20
Length of left mandible	8	0.77-0.82	0.80
Length of postmentum	9	0.86-0.90	0.88
Width of postmentum	9	0.54-0.56	0.54
Length of pronotum	9	0.48-0.53	0.51
Width of pronotum	9	0.79-0.83	0.82

Hospitalitermes schmidt, new species

Figure 3

SOLDIER: Head, except vertex, reddish brown; vertex, genae, and area around rostral hump slightly less dark; antennae, coxae, and femora brown; sternites, tibiae, and tarsi light brown; tergites dark brown. A pair of bristles on the vertex, another pair just behind the rostrum, and one or two on the rostrum; anterior margin of

pronotum fringed with very short bristles; tergites with short scattered bristles; sternites with long bristles. Head shaped as in the figure; profile moderately concave with indication of rostral hump; rostrum rather short. Antennae with 14 articles, second half as long as the third, the latter slightly longer than the fourth. Pronotum nearly twice as wide as long; anterior margin moderately convex.

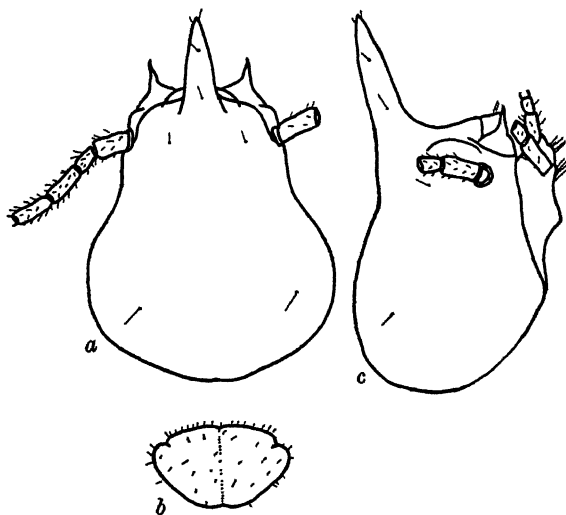


Fig. 3. *Hospitalitermes schmidt*, new species. A, Dorsal view of head; B, pronotum; C, lateral view of head.

MEASUREMENTS (IN MM.)

	No.	RANGE	MEAN
Length of head including rostrum	10	1.62-1.82	1.76
Width of head	10	1.09-1.19	1.15
Length of rostrum (from the tip to the innermost point below the base measured along the axis of the rostrum)	10	0.50-0.58	0.55
Length of pronotum	10	0.31-0.36	0.34
Width of pronotum	10	0.63-0.67	0.64

COMPARISONS: Close to *H. rufus* from Malay from which it can be distinguished by its thicker rostrum, relative length of third and fourth antennal articles (in *rufus* third article is equal to fourth), and slightly less convex margin of pronotum.

Hospitalitermes monoceros from Ceylon is quite close but differs in coloration and length of antennal articles.

TYPE LOCALITY: Lembah Island, north Celebes, June 22, 1929, several soldiers and workers (K. P. Schmidt).

***Hospitalitermes papuanus*, new species**

Figure 4

SOLDIER: Head, except the vertex, dark brown; vertex, antennae, palpi, and tho-

racic and abdominal tergites, and legs brown; tip of rostrum, venter of abdomen, trochanter, and tibial joints light brown. A few bristles on the head, two on the vertex, two at the base of the rostrum and one or two on the rostrum. Tergites with minute and scattered bristles; sternites with long bristles, especially on the posterior side. Head broadly oval behind; profile moderately concave with a slight rostral hump. Antennae with 14 articles, third slightly shorter than the fourth. Mandibles sharply pointed. Pronotum nearly one and a half times as wide as long with a lightly colored streak running lengthwise in the middle and continued onto the mesonotum and metanotum; pronotal angles rounded.

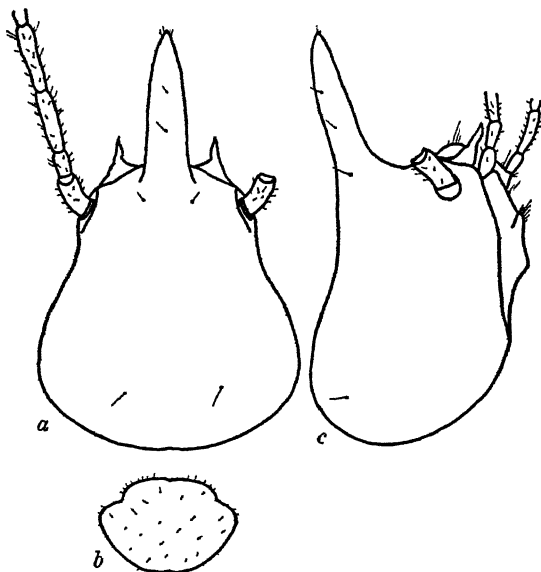


Fig. 4. *Hospitalitermes papuanus*, new species. A, Dorsal view of head; B, pronotum; C, lateral view of head.

MEASUREMENTS (IN MM.)

	No.	RANGE	MEAN
Length of head with rostrum	10	1.80-1.98	1.93
Width of head	10	1.17-1.25	1.22
Length of rostrum	10	0.63-0.73	0.68
Length of pronotum	10	0.40-0.44	0.42
Width of pronotum	10	0.64-0.70	0.68

COMPARISONS: Comes closest to *H. luzonensis* from the Philippines from which it can be distinguished, however, by slightly thicker rostrum, less pronounced rostral hump, and broader head posteriorly.

TYPE LOCALITY: Strickland River, Papua, July 31, 1928, several soldiers and workers (C. E. Pemberton).

***Hospitalitermes moluccanus*, new species**

Figure 5

SOLDIER: Head dark reddish brown; tip of rostrum and area around antennal sockets less dark; basal half of antennae thoracic tergites, coxae, and femora reddish brown; abdominal sternites, trochanters, tibiae, and tarsi light brown. A pair of bristles on the vertex, another pair behind the rostrum and occasionally one or two on the rostrum; pronotum sparsely bristled, bristles very minute; abdominal tergites

with short and scattered bristles, except the last two which have long bristles. Head as in the figure; profile concave; rostrum rather long and slender. Antennae with 14 articles, third a little more than twice as long as second and equal to fourth. Pronotum a little more than one and a half times as wide as long; anterior margin convex; pronotal angles rounded.

COMPARISON: Close to *H. luzonensis* from which it can be distinguished by head being less elevated and less produced behind and having a slightly more slender rostrum. *H. papuanus* has a rostral hump, the head is less rounded behind, and the anterior margin of pronotum is more convex.

TYPE LOCALITY: Waigu Island, Dutch East Indies, June, 1929, two colonies consisting of many soldiers and workers (K. P. Schmidt). "Moving camp from tall tree

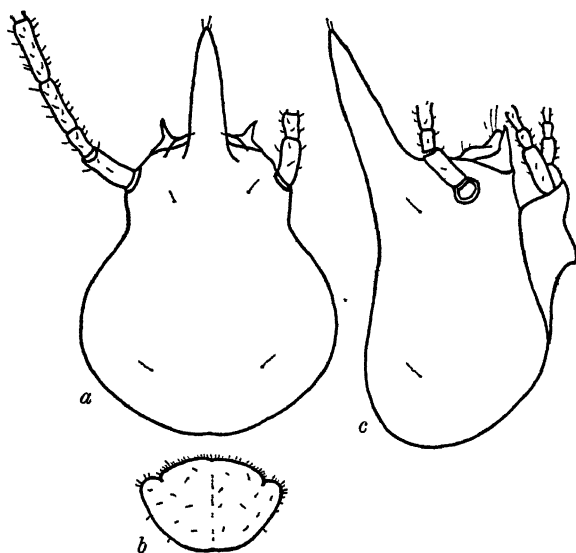


Fig. 5. *Hospitalitermes moluccanus*, new species. A, Dorsal view of head; B, pronotum; C, lateral view of head.

MEASUREMENTS (IN MM.)

	No.	RANGE	MEAN
Length of head with rostrum	10	1.71-1.89	1.84
Width of head	10	1.09-1.21	1.16
Length of rostrum	10	0.57-0.63	0.61
Length of pronotum	10	0.40-0.43	0.41
Width of pronotum	10	0.61-0.69	0.65

to rotten log. Column 60 yards long plus 30 yards on tree."

***Microcerotermes burmanicus*, new species**

Figure 6

SOLDIER: Head testaceous; mandibles dark brown; labrum, first antennal article, pronotum, and coxae brown; antennal articles lighter in coloration; rest of the

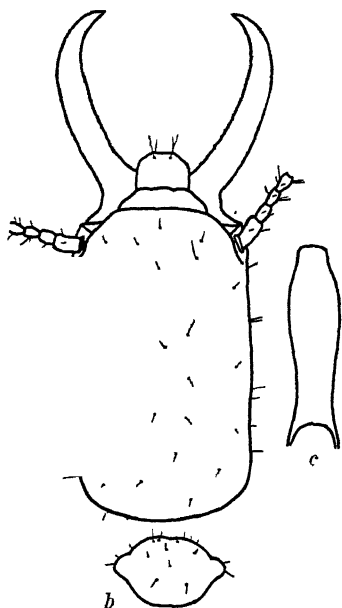


Fig. 6. *Microcerotermes burmanicus*, new species. A, Dorsal view of head; B, pronotum; C, postmentum.

body brownish white. Mandible stout, rather sharply curved at the tip, serration indistinct. Antennae with 13 articles, third a little smaller than fourth, first nearly one and a half times as long as second. Head rectangular, a little more than one and a half times as long as broad,

sides more or less parallel. Pronotum as in the figure.

COMPARISONS: Very close to *M. crassus* from Burma from which it can be distinguished by its smaller but stouter mandibles with tips slightly more sharply curved, and with broader postmentum. *M. championi* from Kumaon, northern India, differs in having shorter head and mandibles with distinct serration.

TYPE LOCALITY: Pagan Road, Rangoon, Burma, May 23, 1935, several soldiers and workers (F. J. Meggitt).

***Microcerotermes philippinensis*, new species**

Figure 7

SOLDIER: Head testaceous anteriorly, lighter posteriorly; mandibles dark brown; antennae, anterior margin of pronotum

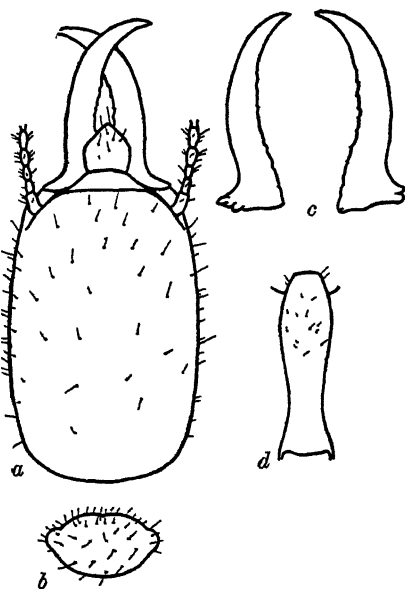


Fig. 7. *Microcerotermes philippinensis*, new species. A, Dorsal view of head; B, pronotum; C, mandibles; D, postmentum.

MEASUREMENTS (IN MM.) OF *MICROCEROTERMES BURMANICUS*

	No.	RANGE	MEAN
Length of head with mandibles	9	2.70-2.88	2.80
Length of head to side base of mandibles	10	1.62-1.71	1.67
Width of head	9	1.01-1.12	1.06
Length of postmentum	9	1.00-1.26	1.10
Width of postmentum	10	0.33-0.36	0.35
Length of pronotum	10	0.32-0.36	0.34
Width of pronotum	10	0.65-0.69	0.67

pale; rest of the body pale white. Pubescence on the head sparse; postmentum with minute hairs in the anterior half; anterior tergites and legs moderately hairy; posterior tergites with long bristles. Head more or less rectangular; mandibles saber-shaped, tips broadly curved, serrations indistinct except for a few notches in the pos-

terior half. Tip of labrum pointed, lateral angles indicated. Antennae with 13 articles, third shortest. Postmentum as shown in the figure. Pronotum nearly twice as wide as long, anterior margin convex, slightly emarginate in the middle, lateral angles rounded.

mandibles, and more pronounced pronotal angles.

COMPARISONS: Differs from *M. losbanosensis* from the Philippines in its considerably longer and broader head, less curved mandibles, and more pronounced lateral angles of pronotum. Quite close to *M. depokensis* from Java from which it can be distinguished by its broader anterior portion of the head, less distinct serrations of

MEASUREMENTS (IN MM.)

	No.	RANGE	MEAN
Length of head with mandibles	9	2.79-2.97	2.29
Length of head to side base of mandibles	10	1.72-1.86	1.79
Width of head	10	1.17-1.26	1.22
Length of postmentum	10	1.16-1.26	1.20
Width of postmentum	10	0.31-0.36	0.35
Length of pronotum	10	0.34-0.37	0.36
Width of pronotum	10	0.68-0.72	0.70

mandibles, and more pronounced pronotal angles.

TYPE LOCALITY: Tarragona, Leyte, Philippines (124° 55' E: longitude and 10° 40' N. latitude), September 15, 1945, several soldiers, workers and nymphs (C. L. Remington). "Basketball-sized nests on coconut trees."

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THE MALE WARNING VIBRATION IN *BUFO*¹

BY ALBERT P. BLAIR²

When sexually excited, male toads of the genus *Bufo* attempt amplexus with virtually any moving object of approximately their own size. Practically, this usually means a male or female toad. Aronson (1944) has shown that in the laboratory male *Bufo americanus* clasp male toads quite as readily as they do females. However, for the conservation of the reproductive potential of the species, it is imperative that some mechanism insure quick release of clasped males. This mechanism has been shown (Aronson, 1944) to be in the nature of a warning vibration given by males when clasped by other males. The warning vibration is given when the male is touched on the back, sides, and sometimes on the top of the head and the hind legs; contact on the throat or ventral side of the toad does not elicit the warning vibration. The method of production of this vibration is not known. It is probably under hormonal control, since it can be elicited in juvenile males by treatment with amphibian and mammalian gonadotrophins and in juvenile toads of either sex by treatment with testosterone propionate (Blair, 1946). The material presented here is in the nature of a comparative study of the male warning vibration in seven species of toads.

Male toads available were as follows:

NO.	SPECIES	SOURCE
9	<i>B. terrestris</i>	Silver Springs, Fla.
7	<i>B. fowleri</i>	Upton, N. J.
6	<i>B. woodhousii</i>	Dallas, Texas
2	<i>B. alvarius</i>	Tucson, Arizona
20	<i>B. marinus</i>	Monterrey, N. L., Mexico
50	<i>B. valliceps</i>	Monterrey, N. L., Mexico
2	<i>B. cognatus</i>	Tucson, Arizona

¹ This investigation was supported by a grant in aid of research from the Committee for Research in Problems of Sex, National Research Council.

² Department of Animal Behavior.

These animals had been in the laboratory, during which time they had been fed on mealworms, cockroaches, and blowflies, for one to four months. All males exhibited the warning vibration when handled. To induce clasping reflex and possibly to heighten the warning vibration, males were injected with fresh whole anterior pituitary of female *Rana pipiens*. Pituitary treatment failed to induce clasping reaction in *B. cognatus* and *B. marinus*.

For comparison of vibrations, kymograph records were made (figs. 1 and 2). A metronome was used to give a one-half second time signal. To the kymograph lever was attached, by means of a movable joint, a rigid metal arm which terminated in a flexible U-shaped clamp. In making a recording, the clamp was placed over the body of the toad with the tips of the arms of the clamp in contact with the sides of the toad. The clamp then served both to stimulate the warning vibration and to transmit the vibration to the lever tracing the record on the smoked drum.

Table 1 summarizes the data on counts of vibrations per second of the toads under consideration. It is apparent that the toads may be divided into three general classes with respect to the number of warning vibrations per second: (1) those with a high frequency (*B. woodhousii* and *B. fowleri*), (2) those with an intermediate frequency (*B. terrestris*), and (3) those with a low frequency (*B. cognatus*, *B. valliceps*, *B. marinus*, and *B. alvarius*). *Bufo woodhousii* and *B. fowleri* are morphologically very similar and have been considered by many workers to be subspecifically related. *Bufo terrestris* is a member of a species complex which includes *B. americanus*, *B. fowleri*, and *B. woodhousii*; its closest rela-

TABLE 1
WARNING VIBRATIONS PER SECOND

Species	Number of Individuals	Total Number of Tests	Number of Vibrations per Second Mean	Range
<i>B. cognatus</i>	2	7	6.5	5-9
<i>B. valliceps</i>	12	40	13.0	9.5-16
<i>B. marinus</i>	3	15	6.9	5-9
<i>B. alvarius</i>	1	4	5.0	5
<i>B. woodhousii</i>	5	12	93.2	84-104
<i>B. fowleri</i>	3	11	93.3	80-104
<i>B. terrestris</i>	9	30	51.3	42-64

tive is *B. americanus*, this relationship having been denoted as subspecific by some recent investigators (Burt, 1938; Netting and Goin, 1946). The four toads with low number of warning vibrations do not constitute a natural group. However, *B. valliceps*, *B. marinus*, and *B. alvarius* are probably more closely related to one another than they are to the *americanus-terrestris-fowleri-woodhousii* complex or to *B. cognatus*. *Bufo cognatus* is a member of a complex which includes *B. compactilis*; although no counts are available, gross observations indicate that *B. compactilis* has the slow vibration found in *B. cognatus*. To a considerable extent, then, vibration frequency may be considered indicative of taxonomic relationship.

The question arises as to the efficacy of slow vibrations in causing release of a male toad with rapid vibrations, and vice versa. Where slow- and rapid-vibrating species occur in the same breeding ponds (*B.*

valliceps and *B. fowleri* in Texas and Louisiana, *B. woodhousii* and *B. cognatus* in the Great Plains) any failure to respond to vibrations of lesser or greater frequency would seem to constitute a barrier to efficient reproduction.

To answer this question extra-specific clasping experiments were conducted. Since there is a fatigue factor in the clasping reaction, males were occasionally allowed to clasp females to determine that the clasping reaction was still present. In general, male toads will not clasp toads much smaller than they are. The seven species of toads used in these experiments may be grouped in two size classes, large (*B. marinus* and *B. alvarius*), and medium (*B. valliceps*, *B. cognatus*, *B. woodhousii*, *B. fowleri*, and *B. terrestris*). No experiment was attempted in which a male toad of the "large" class clasped male or female toads of the "medium" class.

1. EXPERIMENTS WITH ♂ *B. FOWLERI*

<i>B. fowleri</i> No. 1	Placed on	Released spontaneously after	Forcibly removed after
	♀ <i>fowleri</i>		5'
	♂ <i>fowleri</i>	12", 7"	
	♂ <i>valliceps</i>		5' ¹
	♂ <i>woodhousii</i>	59", 4 1/2'	
	♂ <i>fowleri</i>	3", 4"	
	♂ <i>cognatus</i>	8", 3"	
	♀ <i>fowleri</i>		5'
	♂ <i>terrestris</i>	8", 4"	
	♂ <i>woodhousii</i>	12", 2", 4"	
	♀ <i>fowleri</i>		5'
	♂ <i>valliceps</i>	1 1/2', 1'	
	♀ <i>terrestris</i>		10'
	♂ <i>cognatus</i>	18", 9"	
	♂ <i>valliceps</i>	6", 2"	
	♀ <i>fowleri</i>		10'
	♂ <i>valliceps</i>		20'
<i>B. fowleri</i> No. 2	♀ <i>terrestris</i>		5'

¹ *B. valliceps* definitely vibrating.

♀ <i>fowleri</i>		5'
♂ <i>cognatus</i>	22", 4"	
♂ <i>valliceps</i>		10' ¹
♂ <i>fowleri</i>	7", 1"	
♂ <i>terrestris</i>	2", 2"	
♂ <i>woodhousii</i>	7", 3"	

2. EXPERIMENTS WITH ♂ *B. WOODHOUSII*

<i>B. woodhousii</i> No. 1	Placed on	Released spontaneously after	Forcibly removed after:
	♀ <i>terrestris</i>		8'
	♂ <i>cognatus</i>	35", 3"	
	♀ <i>terrestris</i>		5'
	♂ <i>woodhousii</i>	7", 3"	
	♂ <i>marinus</i>		8' ²
	♂ <i>alvarius</i>		10' ²
	♂ <i>valliceps</i>	15", 3"	
	♂ <i>fowleri</i>	3", 2"	
	♂ <i>marinus</i>	8", 15"	
	♀ <i>terrestris</i>		10'

3. EXPERIMENTS WITH ♂ *B. TERRESTRIS*

<i>B. terrestris</i> No. 1	Placed on	Released spontaneously after	Forcibly removed after
	♀ <i>terrestris</i>		5'
	♂ <i>valliceps</i>	2 ³ / ₄ ', 45" ¹	
	♀ <i>fowleri</i>		5'
	♂ <i>cognatus</i>	22", 3"	
	♀ <i>valliceps</i>		5'
	♂ <i>woodhousii</i>	4", 3"	
	♀ <i>fowleri</i>		5'
	♂ <i>terrestris</i>	2", 1"	
	♂ <i>valliceps</i>	2", 3"	
	♀ <i>terrestris</i>		5'
	♀ <i>woodhousii</i>	2", 1"	
	♂ <i>cognatus</i>	1", 1"	
	♀ <i>valliceps</i>	4', 1'	
	♀ <i>terrestris</i>		10'
	♀ <i>valliceps</i>		20'
	♂ <i>marinus</i>		6" ³
	♂ <i>terrestris</i>	5", 4"	
	♂ <i>valliceps</i>	15", 4"	
	♀ <i>terrestris</i>		15'
	♀ <i>terrestris</i>		5'
	♂ <i>valliceps</i>	1 ¹ / ₄ ', 2"	
	♀ <i>valliceps</i>	1', 1'	
	♀ <i>terrestris</i>		10'
	♂ <i>woodhousii</i>	20", 5", 2"	
	♂ <i>cognatus</i>	4", 3"	
	♀ <i>terrestris</i>		7'
	♂ <i>terrestris</i>	1", 2"	
	♂ <i>valliceps</i>	2", 2"	
	♀ <i>fowleri</i>	1', 30" ⁴	
	♀ <i>terrestris</i>		5' ⁴
	♀ <i>fowleri</i>	1', 20" ⁴	
	♀ <i>terrestris</i>		10' ⁴

¹ *B. valliceps* definitely vibrating.² Toad clasped definitely vibrated.³ *B. marinus* vibrating vigorously.⁴ These records are suggestive of sexual isolation; however, it is not the intent of this investigation to inquire into the question of sexual isolation in toads.

<i>B. terrestris</i> No. 3	♀ <i>fowleri</i>		20'
	♂ <i>S. couchii</i> ¹	1 1/3'	
	♀ <i>fowleri</i>		10'
<i>B. terrestris</i> No. 4	♂ <i>terrestris</i>	1', 5"	
	♀ <i>fowleri</i>		5'
	♀ <i>terrestris</i>		10'
	♂ <i>terrestris</i>	4", 5"	
	♀ <i>terrestris</i>		10'
	♂ <i>S. couchii</i>	33", 8"	
	♀ <i>terrestris</i>		5'
	♂ <i>valliceps</i>	25", 10' ²	
	♀ <i>terrestris</i>		5'
	♂ <i>marinus</i>		12' ²
	♂ <i>cognatus</i>	25", 3"	
	♂ <i>marinus</i>		5' ²
	♀ <i>terrestris</i>		5
	♂ <i>terrestris</i>	4", 2"	

4. EXPERIMENTS WITH ♂ *B. ALVARIUS*

<i>B. alvarius</i> No. 1	Placed on	Released spontaneously after	Forcibly removed after
	♀ <i>alvarius</i>		6'
	♂ <i>alvarius</i>	5' ³	
	♀ <i>alvarius</i>		8'
<i>B. alvarius</i> No. 2	♂ <i>marinus</i>	2'	
	♂ <i>alvarius</i>		12' ⁴
	♂ <i>marinus</i>	3", 2"	
	♀ <i>alvarius</i>		10'
	♂ <i>alvarius</i>	8' ⁵	
	♂ <i>alvarius</i>	2' ⁶	
	♂ <i>marinus</i>	2"	

5. EXPERIMENTS WITH ♂ *B. VALLICEPS*

<i>B. valliceps</i> No. 1	Placed on	Released spontaneously after	Forcibly removed after
	♂ <i>woodhousii</i>	6", 4"	
	♀ <i>valliceps</i>		8'
	♂ <i>valliceps</i>	1 1/4', 6"	
	♀ <i>valliceps</i>		6'
<i>B. valliceps</i> No. 2	♂ <i>cognatus</i>	6", 4"	
	♀ <i>valliceps</i>		10'
	♂ <i>woodhousii</i>		10' ⁷
	♂ <i>valliceps</i>	13", 16"	
	♂ <i>marinus</i>	2'	
	♀ <i>valliceps</i>		30'
	♂ <i>cognatus</i>	1 1/2' ⁷	
	♀ <i>valliceps</i>		10'
	♂ <i>terrestris</i>	23"	
	♀ <i>valliceps</i>		15'
	♂ <i>woodhousii</i>		15' ⁷
	♂ <i>cognatus</i>	12"	
	♂ <i>terrestris</i>	5"	
	♀ <i>valliceps</i>		30'

¹ *Scaphiopus couchii* belongs to a different family, Pelobatidae. When seized, the male utters a croak accompanied by a vibratory body movement. The animals used were from Tucson, Arizona.

² Clasped males vibrated vigorously.

³ Clasped ♂ had rather weak vibration.

⁴ Clasped ♂ did not vibrate.

⁵ Clasping ♂ released on third vibration.

⁶ Clasping ♂ released immediately on first vibration.

⁷ Clasped ♂ chirped and vibrated vigorously.

6. EXPERIMENTS WITH ♂ *S. COUCHII*

<i>S. couchii</i> No. 1	Placed on	Released spontaneously after	Forcibly removed after
	♀ <i>terrestris</i>		5'
	♂ <i>valliceps</i>	2", 3"	
	♀ <i>terrestris</i>		3'
	♂ <i>terrestris</i>	5", 3"	
	♀ <i>terrestris</i>		3'

While results are not completely clear cut, certain tentative conclusions may be drawn. Of the *fowleri-woodhousii-terrestris* group, the vibration of any one is usually sufficient to effect release by a male of any species of the group. In two observations on a single individual, the rapid vibration of *B. woodhousii* was found effective in securing release from *B. valliceps*, which has a slow vibration. But in two observations on another individual, the rapid vibrations of *B. woodhousii* were ineffective in causing release from *B. valliceps*, though the rapid vibrations of *B. terrestris* were effective. The slow vibrations of *B. valliceps*, *B. alvarius*, and *B. marinus* are not so effective as rapid vibrations in securing release from the clasp of males of the rapid-vibrating group. The slow vibrations of *B. marinus* are effective in securing release from *B. alvarius*, which has a slow vibration. The

slow vibrations of *B. cognatus* are very effective in securing release from both rapid- and slow-vibrating toads. Why the slow vibrations of *B. cognatus* should be so much more effective than those of *B. valliceps* in securing release from the clasp of rapid-vibrating toads is not at this time apparent.

In general, it would seem that failure of male toads to respond to vibration frequencies of other than their own species constitutes no serious problem in reproduction, with the possible exception of *fowleri-valliceps* pairs. The extent of such difficulty can be determined only by intensive field observations.

It is of interest that *Scaphiopus couchii*, a member of a different anuran family, readily releases male *Bufo* when the clasped toad vibrates. Furthermore, male *Bufo* will not maintain a clasp on male *S. couchii*.

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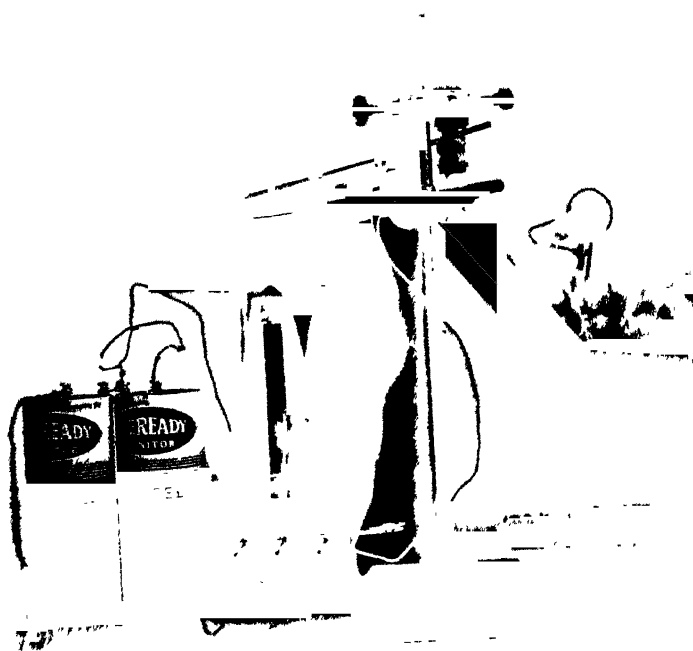


Fig 1. Apparatus for recording vibrations

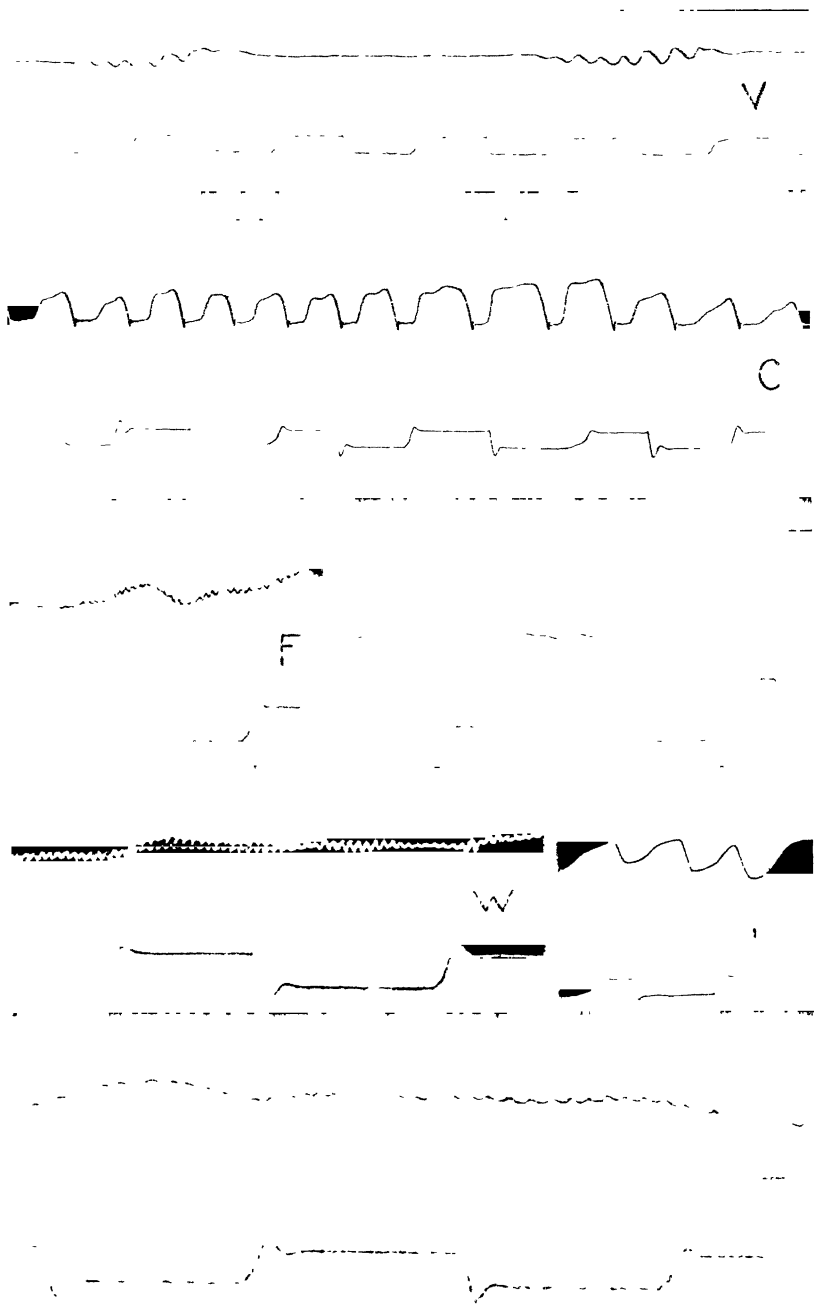


Fig. 2. Kymograph records of vibrations: V, *villiceps*; C, *cognatus*; F, *fowleri*; A, *alvarius*; W, *woodhousii*; M, *marinus*; T, *terrestris*.

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STUDIES OF PERUVIAN BIRDS. NO. 51

THE GENERA *CHLOROTHTRAUPIS*, *CREURGOPS*, *EUCOMETIS*, *TRICHTOTHTRAUPIS*, *NEMOSIA*, *HEMITHRAUPIS*, AND *THLYPOPSIS*, WITH ADDITIONAL NOTES ON *PIRANGA*

By JOHN T. ZIMMER

I am indebted to Messrs. James Bond and Rodolphe M. de Schauensee of the Academy of Natural Sciences of Philadelphia and to Mr. William H. Phelps of Caracas, Venezuela, for the loan of critical material used in the following studies; also to Dr. Herbert Friedmann of the United States National Museum and to Mr. Emmet R. Blake of the Chicago Natural History Museum for courtesies enabling examination of specimens in their respective institutions.

Names of colors are capitalized when direct comparison has been made with Ridgway's "Color standards and color nomenclature."

Chlorothraupis carmioli frenata

Berlepsch

Chlorothraupis carmioli frenata BERLEPSCH, 1907 (Feb.), Ornith., vol. 14, p. 349—Marcapata, Perú; ♂; Frankfort Mus.

Río Távora, 4 ♂, 1 ♀; La Pampa, 2 ♂, 2 ♀; Candamo, 1 ♂, 1 ♀; Pozuzo, 1 ♀.

The wide separation of the range of this form from that of the other members of the species is curious, especially in view of the occupation of the intervening terrain by *C. olivacea* and *C. stolzmanni*. Both of these last-mentioned forms appear to be specifically distinct from *carmioli* with which no intergradation of characters has been discovered at any point. The three species are undoubtedly quite closely related. The pale lores of *frenata* might be considered as suggesting the bright yellow lores of *olivacea*, although the equally conspicuous yellow eye ring of *olivacea* is not similarly suggested, and the re-

semblance in the color of the lores is not very striking, quite aside from the fact that *olivacea* and *carmioli lutescens* occur very near to each other in eastern Panamá.

Two females of *frenata* from Pozuzo and La Pampa, respectively, stand out from the general series of both sexes by reason of their much lighter under parts. The throat is clear light yellow, without any dark stripes or spots; the auriculars are lighter than usual; the lores are as yellow as the throat; the breast is relatively light green; and the belly is broadly yellow without any dark clouding. There is still no suggestion of a circumocular ring, and the characteristics of these birds apparently are due to immaturity. The tips of the rectrices are somewhat more acute than in obviously adult birds, and the remiges and rectrices both lack the firm texture of adult plumage.

Records of *frenata* are from Marcapata, Cosñipata, Yahuarmayo, San Gabán, and Chaquimayo.

Creurgops verticalis Selater

Creurgops verticalis SELATER (J. Verreaux MS), 1858, Proc. Zool. Soc. London, vol. 26, p. 73, pl. 132, fig. 2—Río Napo, eastern Ecuador; type in collection of J. and E. Verreaux, now lost.

Chaupe, 1 ♂, 1 [?♂], 1 ♀; La Lejía, 1 ♀; Cushi Libertad, 2 ♀.

There seems to be no differentiation in the species from its northern range in Colombia to the Junín region of central Perú.

The only other Peruvian locality of record is Ropaybamba.

***Creurgops dentata* (Sclater and Salvin)**

Malacothraupis dentata SCLATER AND SALVIN, 1876, Proc. Zool. Soc. London, p. 353, pl. 31—Bolivia; [♀]; British Mus.

Malacothraupis gustavi BERLEPSCH, 1901 (Jan.), Jour. für Ornith., vol. 49, p. 85—Chaco, Yungas de La Paz, Bolivia; ♂; Berlepsch Coll., Frankfurt.

Malacothraupis castaneiceps CHAPMAN, 1901 (Sept. 12), Bull. Amer. Mus. Nat. Hist., vol. 14, art. 19, p. 225—Inca Mine, Perú; ♂; Amer. Mus. Nat. Hist.

Inca Mine, 1 ♂ (type of "*castaneiceps*"); Santo Domingo, 1 "♀" = ♂.

Bond and de Schauensee (1941, Proc. Acad. Nat. Sci. Philadelphia, vol. 94, pp. 376-377) have given the evidence on which they based their conclusion that "*gustavi*" is the male of the same species of which *dentata*, as described, is the female—a concept which Berlepsch (*loc. cit.*) and Hellmayr (1936, Field Mus. Nat. Hist., zool. ser., vol. 13, pt. 9, p. 346, footnote 3) both considered a possibility. The evidence appears to be sound. Both were collected at Sandillani, Bolivia, a few days apart, and both have been found at Inca Mine, Perú. The Sandillani birds, as sexed by the collector, show the suggested allocation of the two names correctly, in agreement with the types of "*gustavi*" and "*castaneiceps*." The arguments against such arrangement consist solely of a bird in the Academy of Natural Sciences collection from Inca Mine, in the plumage of *dentata* (*sensu stricto*) but sexed as a male, and the bird from Santo Domingo recorded above, in the plumage of "*gustavi*" but sexed as a female. Thus, two of the six known examples with given sex (the type of *dentata* and one Sandillani bird are not sexed by the collectors) must be wrongly sexed, a rather high percentage but perhaps not unduly so considering the paucity of all material. The differences between "*gustavi*" and the description of *dentata* strongly suggest no more than sexual distinctions.

Inca Mine, equivalent to Santo Domingo, is the only Peruvian locality known for this species.

Chapman, in describing "*castaneiceps*," pointed out the close similarity between *Creurgops* and the supposedly distinct

"*Malacothraupis*." Carriker (1936, Proc. Acad. Nat. Sci. Philadelphia, vol. 86, p. 332) formally proposed the generic union, and Bond and de Schauensee adopted this proposal, with which I am in full accord.

***Eucometis penicillata penicillata* (Spix)**

Tanagra penicillata SPIX, 1825, Avium species novae . . . Brasiliam, vol. 2, p. 36, pl. 49, fig. 1—no locality; Fontebôa, Brazil, suggested by Berlepsch, 1908; Munich Mus.

A study of a good series of Amazonian birds confirms the fact that there is a certain lack of uniformity in the present species throughout the course of that stream. Hellmayr early pointed out (1912, Abhandl. K. Bayerischen Acad. Wiss., Math.-Phys. Kl., vol. 26, pt. 2, pp. 12, 13) that the birds from the lower Amazon have somewhat greater measurements than those from the upper part of the stream, and this has subsequently been commented on by other authors, most of whom concurred in the suggestion of possible subspecific distinction.

The problem is, however, complicated by the fact that measurements of the type of *penicillata* have not been recorded, so far as I can determine, although Hellmayr (1910, Novitates Zool., vol. 17, p. 278) remarks that specimens from the Rio Madeira agree with the type in the Munich Museum. Since this was prior to his comment on the larger birds from the mouth of the Amazon, it is not certain that the type may not have been large and hence possibly from farther downstream than Fontebôa which Berlepsch proposed as the restricted type locality for Spix's bird. Until it is possible to examine the type, Berlepsch's restriction will have to be accepted as valid.

There is a certain amount of differentiation shown by the birds of Perú, Ecuador, and southeastern Colombia in comparison with those of the Rio Madeira, Brazil, but it is not very clear-cut. The Rio Madeiran examples have the throat usually whiter and the malar region sometimes invaded by this pallor, while the Peruvian, Ecuadorian, and Colombian examples show more grayish suffusion on the sides and

posterior border of the gular area, with the center of the throat duller than in the Rio Madeiran series. The size is the same in the two series. Since Spix ascended the Amazon beyond Fontebôa, it is possible that his type of *penicillata* actually came from the upper limit of his travels in that direction and would perhaps be assignable to the darker-throated section of the population. His original description calls the throat "albo brunnescenti" while Hellmayr, in his review of Spix's types (1912, Abhandl. K. Bayerischen Akad. Wiss., 2 Kl., vol. 22, no. 3, p. 671) says that the type has the throat white, barely clouded with gray, which is not exact enough to permit restriction to one portion or other of the population. For the present, therefore, it is inadvisable to attempt to break up the upper Amazonian series, although the possible distinctions are worth recording.

The disposition of the birds from the Tocantins and eastward, also, is not at all satisfactory. There is no question that the population in this eastern area averages distinctly larger in dimensions of wing, tail, and bill than the population from the Rio Madeira and westward. Taking available figures from other authors and the measurements of the material at hand, the eastern population shows the males to have the wing 91-99 mm. (average, 94.8); tail, 81-89 (average, 85.4); culmen from base, 19.1-20.2 (average, 19.7); females, wing, 87.5-95 (average, 91.4); tail, 79-87 (average, 91.4); culmen from base, 19.1-20.2 (average, 19.6). For the upper Amazonian population: males, wing, 84-95 (average, 89.8); tail, 71-84 (average, 76.8); culmen from base, 15.8-19.8 (average, 18.3); females, wing, 82-91 (average, 86.2); tail, 72-82 (average, 74); culmen from base, 16.8-19.8 (average, 18.1).

If arbitrary lines of demarcation are set at the following places: male, wing, 92.25; tail, 81.5; culmen from base, 19.3; female, wing, 89.5; tail, 79.5; culmen from base, 19—not over one-quarter of the series will fail to stay within the established limits. The actual overlap of extremes is somewhat greater, and from one-third to

one-half of the total series falls within the zone of dimensions common to both regions. Consequently, although the tendency to greater size at the mouth of the Amazon should be appreciated, the taxonomic distinction of the birds from that area is not assured.

The only Peruvian records not covered by the localities in the series before me are from Iquitos, Pebas, and "Upper Ucayali." The records from Loretoyacu are now transferable to the Colombian list.

SPECIMENS EXAMINED

E. p. penicillata.—

COLOMBIA:

Bogotá, 1 (?);
Loretoyacu, 1 ♂, 1 ♀.

ECUADOR:

Upper Río Suno, 1 ♂.

PERÚ:

Puerto Indiana, 1 ♂;
mouth of Río Curaray, 1 ♀;
Santa Cruz (Hullaga), 1 ♂;
Sarayacu, 2 ♂, 1 ♀;
Lagarto, 2 ♀;
"Ucayali," 1 ♂.

BRAZIL:

Rio Madeira (Humaythá, Calamá, Rosarinho, Santo Antonio de Guajará, Borba, Igarapé Auará), 24 ♂, 17 ♀, 3 (?);
Villa Bella Imperatriz, 2 ♂, 1 ♀, 1 (?);
Rio Tocantins (Ilha Taiuna, Bocca de Manapiri), 3 ♂, 3 ♀;
Maranhão, Ilha Itauna, 1 ♂; 1 ♀;
Rio Negro, Igarapé Cacao Pereira, 1 ♂, 1 ♀.

E. p. albicollis.—

BRAZIL:

Matto Grosso (Chapada, Urucum de Corumbá, Descalvados, Tapirapoan, Belvedere de Urucum, and São Lorenzo River), 23 ♂, 17 ♀, 3 (?).

BOLIVIA:

Todos Santos, 1 ♂.

E. p. affinis.—

VENEZUELA:

(Las Trincheras, San Carlos, Cumbre Chiquitos, and Las Quiguas), 3 ♂, 3 ♀, 1 (?).

E. p. cristata.—

COLOMBIA:

(Río Lima, Guevara, El Consuelo, "Bogotá, and "Colombia"), 1 ♂, 2 ♀, 9 (?);
Santa Marta (Donama, Bonda, Cacagualito, and Onaca), 3 ♂, 2 ♀, 3 (?).

PANAMÁ:

(El Real, savanna near Panamá, Tocumé, Cape Garachiné, Gatún, Darien, and Lion Hill), 4 ♂, 13 ♀, 1 (?).

E. p. stictothorax.—

PANAMÁ:

(El Banco, Bogava, Bugaba, Chiriquí, Jicarón Is., Sevilla Is., El Villano, Santa

Fé, La Marea, Wilcox Camp, and La Colorada), 20 ♂, 7 ♀, 2 (?).

COSTA RICA:

(Paso El Boruca, Boruca, Volcán de Oso, El Pozo, and Puerto Jiménez), 6 ♂, 3 ♀.

E. p. spodocephala.—

COSTA RICA:

(Las Cañas, Nicoya, and Miravalles), 5 ♂, 4 ♀.

NICARAGUA:

(Volcán Chinandega, Tuma, MuyMuy, Chinandega, Volcán Viejo, and Río Grande), 3 ♂, 6 ♀.

***Trichothraupis melanops* (Vieillot)**

Muscicapa melanops VIEILLOT, 1818, Nouveau dictionnaire d'histoire naturelle, nouv. éd., vol. 21, p. 452—based on "Lindo pardo copete amarillo" Azara, No. 101; Paraguay.

Tachyphonus quadricolor VIEILLOT, 1819, *op. cit.*, vol. 32, p. 359—"Brésil."

Tanagra auricapilla WIED, 1821, Reise nach Brasilien, vol. 2, p. 212—Arrayal de Conquista, Bahia, Brazil; [♂]; Amer. Mus. Nat. Hist.

Muscicapa galeata LICHTENSTEIN, 1823, Verzeichniss der Doubletten des Zoologischen Museums der Berliner Universität, p. 56—São Paulo, Brazil; Berlin Mus.

Tachyphonus suchii SWAINSON, 1825 (Oct.), Quart. Jour. Sci., Litt., Arts Roy. Inst., vol. 20, No. 39, p. 66—southern parts of Brazil; Univ. Mus., Cambridge, England.

This species has been recorded from Huambo, Amable Maria, Ropaybamba, and Pumamarca, but I have seen no Peruvian examples. There is a slight possibility that distinctions might be found in Peruvian specimens as compared with Paraguayan and Brazilian material, but the range of variation in the species is so great (126 specimens examined) that little is to be expected. Two adult males from Bolivia (Province of Sara) have a greater posterior extension of the black area on the sides of the face than any other males at hand from any locality, but there is considerable variation within this extreme limit. These two males also have the longer upper tail-coverts decidedly blackish, with narrow olive tips, but this character is present in a small number of Brazilian and Argentine birds, also, and is of doubtful taxonomic value. The relatively pale yellow crest of the Bolivian specimens is likewise valueless since it occurs irregularly in other parts of the specific range. Hellmayr at one time (1906, Abhandl. Bayerischen Akad. Wiss., 2 Kl., vol. 22, no. 3, p. 674) proposed to

recognize a separable form, *auricapilla*, on this basis (and several others), but later found the characters to be instable. Curiously enough, the type of *auricapilla*, which Hellmayr appears not to have seen, has a deeply colored crest.

***Nemosia pileata nana* Berlepsch**

Nemosia pileata nana BERLEPSCH, 1912 (Feb.), Verhandl. 5 Internatl.-Ornith. Congr., Berlin, pp. 1084, 1141—Río Samiria, northeastern Perú; ♂; Frankfort Mus.

This small, dark form ranges somewhat more widely than has been recorded. A single male from Rosarinho, left bank of the Rio Madeira (near its mouth), Brazil, is a little larger than any Peruvian male at hand, agreeing with the smallest examples of *N. p. pileata* which appears to occupy the region between the Madeira and the Tapajoz and to cross the Madeira to its western side near Marmellos, some distance above Rosarinho.

Study of a large series of birds from all parts of the specific range has indicated the desirability of further breaking up the species, since certain definite segregation of characters is evident in different parts of the population. In order to provide names under which the characters may be discussed, it may be well to define two new forms that require naming. These may be known as follows:

***Nemosia pileata interna*, new subspecies**

TYPE: From Igarapé Cacao Pereira, lower Rio Negro (left bank), Brazil. No. 313348, American Museum of Natural History. Adult male collected January 21, 1930, by the Olalla brothers.

DIAGNOSIS: Similar to *N. p. pileata* of French Guiana in coloration, but smaller. Size about like that of *P. p. nana* of northeastern Perú, but dorsal coloration lighter gray.

RANGE: Left bank of lower Rio Negro to the upper Rio Branco region, northern Brazil.

DESCRIPTION OF TYPE: Top of head and sides of head behind and under the orbit glossy black; a small dusky bar on lower part of lores from orbit to base of bill; upper part of lores white; hind neck

and back Deep Green-Blue Gray. Under parts largely white with the black of the sides of the head continued onto the sides of the breast, and the flanks and thighs distinctly grayish; thighs deeper gray. Remiges black, with outer margins of primaries, except outermost, narrowly Cadet Gray, becoming obsolete distally; outer margins of secondaries slightly deeper in hue and progressively broader, being supplemented on the inner feathers by a narrow exterior line of white near the tips; tertials a little duller with the gray portion reaching the shaft and crossing to the inner web at least distally where there is also a narrow terminal whitish edge, most conspicuous on the two longer feathers; the longest tertial also has a fairly strong whitish outer margin on the outer web; greater upper wing-coverts a little duller than the back, with narrow white outer margins on some of the outer feathers; median and lesser series near Delft Blue; alula and primary-coverts black with narrow blue outer margins; under wing-coverts white, with a blue area along the carpal margin. Median rectrices like the back; remainder blackish, with outer margins of all but outermost pair bluish; outer pair with a white inner margin, also present but more restricted on subexternal pair. Bill (in dried skin) black; feet yellow. Wing, 66 mm.; tail, 42.5; exposed culmen, 11; culmen from base, 12.4; tarsus, 17.

REMARKS: The five adult males in the series measure: wing, 62.5-67 (average, 65.5); tail, 40-42.5 (average, 41.1); culmen from base, 11.8-12.4 (average, 12.0). Two females measure: wing, 62.5, 63.0; tail, 40.0, 41.0.

In comparison, 10 males of *p. pileata* measure: wing, 66-70.3 (average, 67.5); tail, 42-45.5 (average, 44.3); culmen from base, 11.1-12.9 (average, 12.0). Eight females measure: wing, 63-68 (average, 66); tail, 40-44.8 (average, 42.5).

***Nemosia pileata surinamensis*, new subspecies**

TYPE: From near Paramaribo, Surinam. No. 511112, American Museum of Natural History. Adult male collected May 14, 1899, by W. A. Penard.

DIAGNOSIS: Similar in coloration to *N. p. nana* of northeastern Perú, but larger. Averaging slightly larger than *N. p. pileata* of French Guiana but with dorsal coloration darker.

RANGE: Surinam and British Guiana.

DESCRIPTION OF TYPE: General pattern as for *N. p. interna* described above, but back deeper in hue, somewhat clearer than Payne's Gray; outer margins of primaries Pale Windsor Blue; white outer edges of inner secondaries and tertials obsolete but those on greater upper wing-coverts present; white inner margins of outer rectrices obsolete; median and lesser upper wing-coverts Tyrian Blue. Wing, 70 mm.; tail, 46; exposed culmen, 11.1; culmen from base, 12.1; tarsus, 18.4.

REMARKS: Eleven males from Surinam and British Guiana show a wing measurement of 67.5-74 (average, 70); tail, 43.5-48 (average, 45.1); culmen from base, 11.1-12.9 (average, 12.3). Four females measure: wing, 66-68.5 (average, 66.9); tail, 43-44 (average, 43.2).

Paraguayan birds were named *paraguayensis* by Chubb (1910, Ibis, ser. 9, vol. 4, p. 629) on account of larger size in comparison with *pileata* from "Guiana." While Paraguayan and northwest-Argentine birds are at the maximum in regard to measurements, there is little distinction between them and the birds of southeastern Brazil, from the Tapajoz to São Paulo. Three Paraguayan males have the wing 76-77.5 mm. in length; a fourth, 74; and a male from Embarcación, Salta, Argentina, 75.5. One male from Urucum, Matto Grosso, also has the wing 74 and one from Viçosa, Ceará, only 69, but 29 other males from southeastern Brazil have this member 70-75.5. The tail measures 42.5-50, no longer in the Paraguayan series than in the remainder. Culmen from base, 12-14.2.

On the other hand, 10 males of *pileata*, from the Guianas, the north bank of the lower Amazon, and from a portion of the Madeira and between this stream and the Tapajoz, have the wing but 66-70.3; the tail, 40-45; and the culmen from base, 11.1-12.9. It seems best, therefore, to as-

sociate the southeast-Brazilian bird with the Paraguayan, not with *pileata pileata*.

This necessitates the use of another name for the large southern form. Examples from Bahia were named *H[ylophilus] caeruleus* (based on the female) and *H. cyanoleucus* (male) by Wied (1831, Beiträge zur Naturgeschichte von Brasilien, vol. 3, pt. 2, pp. 731 and 734, respectively). I adopt the name *caerulea* for this form, under which *paraguayensis* should be listed as a synonym. The types of Wied's supposed two forms unfortunately were not among the specimens of his collection received by the American Museum of Natural History, but the application of the names is unquestionable.

It may be suggested that the few examples from the upper Rio Madeira and between that stream and the Tapajoz could be considered as intermediates between *caerulea* and the small, dark *nana* of northeastern Perú. While this is a possibility, these characters are those of *pileata pileata* from which the skins in question cannot be distinguished. A single male from the left bank of the lower Madeira, on the other hand, is typical *nana*.

As noted in the description of *interna*, there is a small, relatively light-backed form on the lower Rio Negro and north to the upper Rio Branco. This might be expected to pass into the characters of the British Guianan population, but the distinction there is quite pronounced since the British Guianan and Surinam birds are quite dark and nearly as large as *caerulea*. Females of all these forms are not clearly distinguishable in coloration, although they tend to match the distinctions of the males both in color and size.

The north-Colombian *hypoleuca* is much more widely distributed than has been recorded. Hellmayr (1936, Field Mus. Nat. Hist., zool. ser., vol. 13, pt. 9, p. 369) assigns north-Venezuelan records to typical *pileata*, although (p. 371) he recognized the existence of *hypoleuca*. Through the kindness of Mr. William H. Phelps of Caracas, I have been able to examine seven males and five females from various parts of northern and eastern Venezuela which Mr. Phelps had identified as *hypoleuca*, and I

find myself in accord with this assignment. One male in worn plumage from Cerro Tomasote, El Palmar, Bolívar, a little south of the lower Orinoco, might have been expected to approach either *surinamensis* or *interna*, but it agrees with the other Venezuelan examples as nearly as can be determined from its worn plumage.

To recapitulate: *caerulea* is the largest and dorsally palest form; *pileata* is somewhat smaller and slightly darker; *hypoleuca* is about the same size as *pileata* but has more purely white flanks; *surinamensis* is larger than *pileata* and smaller than *caerulea*, and is relatively dark above; *interna* is small and light backed; *nana*, small and dark.

SPECIMENS EXAMINED

N. p. pileata.—

FRENCH GUIANA:

Cayenne, 3 ♂, 2 ♀;

Mana, 1 ♂, 1 ♀.

BRAZIL:

Faro, 2 ♂, 2 ♀;

Monte Alegre, 1 ♂;

Rio Madeira, Igarapé Auará, 1 ♀;

Marmellos, 2 ♂, 2 ♀;

Villa Bella Imperatriz, 1 ♂, 1 ♀.

N. p. surinamensis.—

SURINAM:

Near Paramaribo, 9 ♂ (including type), 2 ♀;

Little Wanica, 2 ♀.

BRITISH GUIANA:

Demerara, 2 [♂].

N. p. hypoleuca.—

COLOMBIA:

Cartagena, 1 ♂, 1 ♀;

Lorica, 1 ♀;

Jaraquiel, 1 ♂.

VENEZUELA:

Zulia, Villa del Rosario, 1 ♂¹;

Mene Grande, 2 ♂¹, 1 (♀)¹;

Santa Barbara, 1 ♂¹;

Perijá, San Rafael, 1 [♂]¹;

Machiquez, 1 ♀¹;

Lara, Quebrada Arriba, 1 ♂¹, 2 ♀¹;

Guarico, Altigracia de Orituco, 1 (? ♀)¹.

N. p. interna.—

BRAZIL:

Rio Negro, Igarapé Cacao Pereira, 1 ♂ (type), 1 ♀;

Rio Surumú, Frechal, 4 ♂.

N. p. caerulea.—

BRAZIL:

Marajó, Bôa, Vista, 1 ♂;

S. Natal, 1 ♀;

¹ Specimens in collection of William H. Phelps, Caracas.

Rio Tocantins, Baião, 1 ♂;
 Maranhão, Flores, 2 ♂;
 Riachão, 1 ♂;
 Baião de Grajau, 1 ♂;
 Ceará, Viçosa, 1 ♂, 1 ♀;
 Piahy, Corrente, 3 ♂, 2 ♀;
 Urussuby, 1 ♀;
 Bello Horizonte, 1 ♀;
 Bahia, "Bahia," 4 ♂, 4 ♀;
 Jaguaquara, 2 ♂;
 Santa Ritta, 4 ♂, 5 ♀;
 Orobo, 1 ♂, 1 ♀;
 Iracema, 1 ♂, 1 ♀;
 Jequié, 1 ♂;
 Morro de Chapau, 1 ♀;
 Espírito Santo, Lagôa Juparaná, 1 ♀;
 Minas Gerais, Pirapora, 1 ♂;
 São Paulo, Itapura, 1 ♀;
 Matto Grosso, Chapada, 3 ♂, 3 ♀;
 Urucum de Corumbá, 2 ♂, 6 ♀;
 Belvedere de Urucum, 1 ♀.

PARAGUAY:

Trinidad, 2 ♂;
 La Fonciere, 1 ♂;
 Ypané River at Niu Pona, 1 ♂, 1 ♀.

ARGENTINA:

Salta, Embarcación, 1 ♂.

BOLIVIA:

Todos Santos, 2 ♂, 1 ♀;
 Prov. Sara, 750 m., 1 ♀.

N. p. nana.—

PERÚ:

Sarayacu, 2 ♂, 1 ♀;
 "Upper Ucayali," 1 ♂;
 mouth of Cahuapanas, 1 ♂.

BRAZIL:

Rosarinho, 1 ♂.

Hemithraupis guira guirina (Sclater)

Nemosia guirina SCLATER, 1856, Proc. Zool. Soc. London, vol. 24, p. 110—New Grenada, Bogotá, and eastern Perú; restricted to Bogotá by Berlepsch, 1912; British Mus.

There is some uncertainty with regard to the strict application of the name *guirina*, since two different forms are represented in Bogotá collections, although only one of them is known to reach Perú. Hellmayr (1936, Field Mus. Nat. Hist., zool. ser., vol. 13, pt. 9, p. 378, footnote) has stated the problem. The original description was based on three specimens—two Bogotá trade-skins and one example from "Guaunco" [= Huánuco], Perú. These Sclater found to differ from "*guira*" (with which he included specimens now assignable to *nigrigula*) by larger size, darker ("deep chestnut tinge") breast, and absence of the post-gular yellow band, together with a supposedly greater development of yellow on the sides of the neck.

This last character is not worth consideration, since the preparation of the skin affects the appearance of this yellow marking which is variable in all populations. The absence of post-gular yellow is definitive as between *guira* and *nigrigula* together in comparison with the whole Andean series, but it does not help in the restriction of the name *guirina*. The size (wing, 2.9 in.; tail, 2.0) is not definitive so far as the tail is concerned, but the wing measurement is larger than that of any Andean specimen I have, with the nearest approach in specimens from the Central Andes of Colombia, as discussed below. Some Peruvian birds are not far below it, and most "Bogotá" birds are intermediate in this respect. Sclater's birds can thus hardly be placed accurately by the measurements given in the original description.

The use of the term "deep chestnut tinge" would seem, however, to be definitive enough for the purpose. The Bogotá birds show two extremes of coloration of the breast, one of which is near Raw Sienna, as it is in *guira* and *nigrigula*, while the other is much darker, a little lighter than Amber Brown which Sclater might have called "chestnut" although he could hardly have applied the term to the lighter hue.

Hellmayr lays stress on Sclater's use of the word "*flavis*" for the superciliary stripe which is brownish in the dark-chested birds and yellower in the others, as it is in *guira* and *nigrigula*. Some of the darker-breasted examples have this stripe distinctly yellowish, in any case. Sclater also says that the yellow cervical and superciliary areas meet, but this factor requires confirmation since it is not apparent in any of the Andean birds I have seen or in *nigrigula*. It is a character of the various forms found in Brazil south of the Amazon and other countries to the southward, but not in the Andean region.

For these reasons, therefore, I believe the name *guirina* should be restricted to the darker-breasted population as represented in Bogotá collections, the range of which actually occupies central and western Colombia and possibly western Ecuador

and extreme northwestern Perú, and to establish the distributional facts, I propose Antioquia, Colombia, as a restricted type locality, more definitive than "Bogotá" where the bird does not occur.

This western population may deserve still further subdivision, but it is difficult to say where a line of separation should be placed. The central Colombian males and two dark-breasted Bogotá-skins have the wing 69–71.5 mm.; the tail, 52.9–58. The largest bird is from near Honda. Three west-Colombian males have the wing 69–71; tail, 50.5–55. A male from Chimbo, western Ecuador, is recorded by Taczanowski (1884, *Ornithologie du Pérou*, vol. 2, p. 554) as having the wing 64; tail, 50.

The maximum figures are thus above those available for the east-Colombian birds and those from eastern Ecuador and north-central Perú, but the difference is not great. This eastern population shows the males with wing 62–72; tail, 45–55. Excluding doubtful specimens, of which more will be said later, the average would be larger, with the wing 66.3–72; tail, 48–55. The largest specimen in this series is a Bogotá-skin; the next largest is from northern Perú.

My west-Colombian males all have the superciliary stripe very weak and brownish, and a male from Río Frio, Cauca River, and one Bogotá-skin are very similar. Taczanowski's description of the Chimbo male shows it to have been of the same nature. A male, collected by Goodfellow and Hamilton in Ecuador and said to have come from Archidona, east of the Andes, agrees quite closely, but this last specimen probably was obtained in western Ecuador; Goodfellow and Hamilton's localities are notoriously unreliable.

One other Bogotá-skin, a specimen from near Honda, one from "Antioquia," and a fourth from La Frijolera have the superciliary stripe broader and yellower than the west-Colombian examples, but still not so clear yellow as in more eastern examples. The assignment to *quirina*, as I have restricted that name, is indicated by the dark color of the breast.

We have, then, the birds of the Central Andes of Colombia diverging from the east-

Colombian birds by showing the superciliary stripe deeper yellow or sometimes distinctly brownish and sometimes greatly reduced in size, while the wing and tail average very slightly longer than in the more eastern population. In western Colombia, the character of the obsolescent superciliary stripe is emphasized, while the wing and tail return to lengths more nearly as in the average eastern birds. In western Ecuador, however, the superciliary stripe remains inconspicuous, while the wing and tail become even shorter. A long series from the western Andes of Colombia and Ecuador may show some definite preponderance of characters in parts of the area that will permit the delimitation and naming of a separate form. For the present, I hesitate to define such form. In particular, I am unable to separate the west-Colombian birds from *quirina* at the present writing.

Taczanowski (*loc. cit.*) included in his account of *quirina* the description of a female from Santa Lucia, extreme northwestern Perú, which supplies the only record that is likely to be assignable to *quirina* (or a still smaller west-Ecuadorian form). This female is said to have the wing 63 mm.; the tail, 50. A female at hand from Chimbo, western Ecuador, has the wing 60; tail, 47. This is the smallest bird in the whole Andean series. The Santa Lucia bird appears to have been larger than the minimum of north-central Peruvian females but a little smaller than any of the central and west-Colombian birds of that sex now at hand. Obviously, more material is needed from the far western region. In the meantime, I refer the Santa Lucia record tentatively to *quirina*.

Hemithraupis guira huambina

Sztolcman

Hemithraupis guira huambina SZTOLCMAN, 1926 (Dec. 31), *Ann. Zool. Mus. Pol. Hist. Nat.*, vol. 5, p. 233—Huambo, Perú; ♂; Warsaw Mus.

The three dubious specimens mentioned above are very similar to the other specimens I refer to *huambina* except that they are somewhat smaller. One is from W. E.

Moore's "Napo" collection, but may not have come from the Napo (see discussion of *Tachyphonus surinamus napensis* in Amer. Mus. Novitates, no. 1304, pp. 20-21, 1945); another is from Loretoyacu, Colombia; the third is labeled "Ecuador Wallace" though without an original label. With them may be placed a male from Sarayacu, Perú, and one from Rosarinho, Brazil. In the order mentioned, the wing measures: 62, 64, 67.2, 61.8, 63.9; tail, 45, 53, 48, 46.5, 47.5. The Loretoyacu bird is certainly from north of the Amazon, but the "Napo" and "Ecuador Wallace" examples may not be since they agree best with the Sarayacu and Rosarinho skins in their smaller size. This small dimension shows an approach toward the form from the south bank of the lower Amazon of which more will be said below.

The pattern of these five birds is not decisively different from the general series of *huambina*. All of them have the yellow superciliary stripe narrowly separated from the cervical patch. The series of *huambina* varies in the degree to which this separation is shown, but in no case are the two yellow areas quite confluent. There is always a small greenish patch in the interspace. The Rosarinho bird has a minimum of this as might be expected from the position of the locality, but the yellow is still not quite continuous. In some cases the hiatus is relatively broad, but both extremes, short of continuity, are found from eastern Colombia to northern Perú.

In spite of the smaller size of four of the five birds, therefore, I believe they should be referred at present to *huambina* and their shorter measurements ascribed to a trend toward the lower Amazonian population which is similarly small.

All Peruvian records, with the possible exception of that from Santa Lucia which may be *guirina*, thus appear assignable to *huambina*, including Perico, Yurimaguas, Huánuco, and Huambo.

Hemithraupis guira guira (Linnaeus)

Motacilla guira LINNAEUS, 1766, *Systema naturae*, ed. 12, vol. 1, p. 335—based on "Guiraguacu-beraba" Marcgrave; northeastern Brazil = Pernambuco (Berlepsch, 1912).

Descending the Amazon to the Pará region, it appears that birds from the Rio Tocantins eastward and southward through Goyaz, Piauí, Maranhão, Ceará, and northwestern Bahia are fairly uniform and may be associated in the subspecies *guira*, whose type locality was restricted by Berlepsch in 1912 to Pernambuco (although recent collectors appear to have failed to secure examples in that state).

This form is easily distinguished from *nigrigula* of Cayenne. A new extreme is reached in the paleness of the color on the breast and, although the darker examples of *guira* can be matched in the series of *nigrigula*, most of them are definitely paler on breast and uropygium. The olive color of the back also is lighter and brighter in most of the examples of *guira*. The yellow post-gular band is not so prominent as in *nigrigula* and is often absent. The superciliary stripe and the cervical patch, broadly separated in *nigrigula*, and moderately to broadly in *huambina*, are strongly confluent in *guira*, making a complete yellow border behind the auriculars. The size of the two forms is about the same.

Farther up the south bank of the Amazon, near the Tapajoz and Madeira rivers, the birds retain the small size of *guira* and, in the males, the yellow border behind the auriculars, but the dorsal coloration is darker olive and the breast and rump are somewhat deeper colored, while the yellow post-gular band usually is more prominent than in most *gularis*. They are thus closer to *nigrigula* than is *gularis*, being distinguishable from *nigrigula* by the post-auricular yellow lunule. Since no name is available for this population, it may be known as follows:

Hemithraupis guira amazonica, new subspecies

TYPE: From Tauary, Rio Tapajoz (right bank), Brazil. No. 288048, American Museum of Natural History. Adult male collected April 14, 1931, by Alfonso M. Olalla.

DIAGNOSIS: Similar to *H. g. nigrigula* of the Guianas and Brazil, north of the Amazon, but differing in the male sex by having the yellow superciliary stripe and cer-

vical patch broadly confluent behind the auriculars. Differs from *H. g. guira* of the region from the Rio Tocantins to northwestern Bahia by the darker olive back, deeper brownish breast and rump, and usually more prominent yellow post-gular bar.

RANGE: South bank of the Amazon from the right bank of the Tapajoz westward to the east bank of the Madeira.

DESCRIPTION OF TYPE: Top of head and mantle Dark Citrine $\times$ Warbler Green; lower back Mars Yellow $\times$ Sudan Brown, becoming more yellowish in a very limited area adjacent to the upper tail-coverts which are like the mantle. A broad stripe of Lemon Chrome from the sides of the forehead over the orbit and around the back of the auriculars where it connects, still more broadly, with an area of the same color on the sides of the neck; chin, throat, auriculars, upper eyelid, and lores Chaetura Black, extending narrowly to the nostrils in front of the anterior end of the superciliary stripe; breast and sides near Raw Sienna, noticeably tinged with yellow at the upper border, forming a sort of continuation of the yellow cervical area; the brown color is prolonged posteriad well down the middle of the belly where it is bordered broadly by Lemon Chrome; flanks grayish, washed with yellowish green; under tail-coverts deep Lemon Chrome with the shorter feathers broadly tipped with Raw Sienna. Remiges blackish brown, exteriorly edged with green a little more yellowish than the color of the back, broadest on the tertials where the margins are still paler toward the tips; exposed portions of greater, median, and lesser coverts like the back; primary-coverts largely sooty with very narrow greenish outer margins; under wing-coverts and inner margins of remiges whitish; carpal margin greenish. Tail dark brown, with outer margins (and inner margins of median pair) greenish; inner margins of others than the median pair narrowly yellowish. Bill (in dried skin) with maxilla blackish brown with a pale area at base of commissure; mandible flesh colored; feet dull grayish. Wing, 64.5 mm.; tail, 51; ex-

posed culmen, 11; culmen from base, 14; tarsus, 16.

REMARKS: Although this form is, in a sense, intermediate between *guira* and *huambina*, it is not easily assigned to either. It is closer to *guira* than to *huambina* but represents an extreme of coloration that is quite noticeable in series and in most cases in individual skins.

Whereas *guira* frequently has a broad yellow band across the forehead as in the more southern *fosteri*, there is no more than a suggestion of it in any of the specimens of *amazonica*, nor, for that matter, in the majority of *guira*. In *fosteri*, however, the reverse is true, and most of the males of that form have a pronounced frontal band of yellow, sometimes 10 or 12 mm. in width. The yellow post-gular area, present in *guira*, is lacking in *fosteri* which, in addition, has the pectoral and uropygial areas deeper rufous brown than in *guira*, *amazonica*, or *huambina*, though not so dark as in *quirina*.

These characters, therefore, serve to distinguish the known forms in this part of the continent. Circling back north-eastward from Paraguay, the type region of *fosteri*, there is encountered another combination of characters that is not in agreement with those of the forms mentioned. This combination is most constant in the birds at hand from northeastern Bolivia which I have chosen as the distributional focus of a new form to be known as follows:

Hemithraupis guira boliviana, new subspecies

TYPE: From Todos Santos, Province of Cochabamba, Bolivia; altitude 1300 feet. No. 138449, American Museum of Natural History. Adult male collected July 21, 1915, by Leo E. Miller and Howarth Boyle; original no. 13041.

DIAGNOSIS: Similar to *H. g. amazonica* described above, but averaging larger; back averaging lighter green; breast darker brown but rump averaging paler; post-gular yellow area usually lacking, rarely pronounced. Differs from *H. g. fosteri* of Paraguay and extreme southeastern Brazil

by having darker dorsal coloration and lacking the yellow frontal band; throat averaging more deeply blackish.

RANGE: Northeastern Bolivia; possibly also the Matto Grosso region of western Brazil.

DESCRIPTION OF TYPE: General pattern as described above for *amazonica* but back Warbler Green $\times$ Pyrite Yellow; breast and sides dark Raw Sienna with a very slight tinge of yellow on the upper border; rump near Mars Yellow, passing into clear yellow on the shorter upper tail-coverts; under tail-coverts yellow. Wing, 68.2 mm.; tail, 51; exposed culmen, 11; culmen from base, 14; tarsus, 16.

REMARKS: The specimens from Bolivia are relatively uniform, but there is some question about the series from various localities in Matto Grosso, Brazil. This region appears to be a mixing bowl for the characters of all the surrounding populations of this species. The birds from Chapada are large and, with one exception, without the yellow frontal band of *fosteri*, but they are lighter in color than the Bolivian skins, again with one marked exception—the same bird that has a certain amount of yellow on the forehead.

Four males from Urucum de Corumbá and Belvedere de Urucum, although the localities are between Chapada and Paraguay, do not approach *fosteri* except that one of the specimens has a little yellow on the forehead. The Urucum bird is very like typical *guira* in its very pale breast with noticeable yellow adjacent to the throat. The three birds from Belvedere are darker and are more like *amazonica*, although not certainly referable to that form because of geographical complications. They agree well enough with the Bolivian birds in coloration, although one of them has a tinge of yellow on the front, but they are small, like *guira*, having the wing 63.7–66.6; tail, 48–52.5. The Chapada males, perhaps because more are available for measurement, average larger, with wing 64.5–69.2; tail, 49.1–54.5. The Bolivian males measure: wing, 60.5–66.2; tail, 44.5–52. Males of *fosteri* show: wing, 60.8–70.7; tail, 51–57.

The mixture of characters in Matto

Grosso birds thus prevents a clear assignment of the population to one form or another, and equally prevents any separation as a distinct form. It seems best, therefore, to place the population at least temporarily in *boliviana* with which there is better agreement in one way and another than is shown with any other single form.

Considerable attention has been given to the possibility of uniting the *ruficapilla* and *guira* groups. There is no doubt that they are very closely related and, as far as I am able to demonstrate, they replace each other geographically. Some of the localities of record of one group or the other come very close together, but I can find no positive conflict where the record is based on males. Any records based solely on females is questionable, since the females of these two groups are virtually inseparable. Females of *guira fosteri* at hand are relatively bright yellowish on the under parts, those of *guira guira* a little less so, and those of the *ruficapilla* aggregation duller and often markedly grayish in tone, but there are exceptions in all parts of the ranges.

The continuity between *guira guira* and *g. fosteri* appears to be effected through the valleys of the Rio São Francisco and the Rio Paraná and their upper affluents, and the ranges ascend the lateral affluents, such as the Paranapanema, for a considerable distance toward the coastal highlands. On the other hand, while *ruficapilla* and its Bahian representative are found on the coastal side of these highlands, they also occur on the western slopes, apparently above the points reached by the *guira* group. On the meeting ground, there is no obvious barrier to intermingling of the populations or any demonstrable intergradation of a gradual sort, although a number of hybrids are extant, two of which are now before me. Both have the head pattern of *ruficapilla* but with the brown color of that region considerably darkened though not so blackish as in the *guira* group. One of the birds, from Coredeiras, São Paulo, has the head darker than the other and, in addition, has a suggestion of lighter brown on the forehead and a prominent brownish yellow supra-auricular

stripe. The other bird is from Jequié, Bahia.

Several other skins show peculiar characteristics that are not so certainly ascribable to hybridization. A Bahia trade-skin has the brown of the head darker and duller, less warmly hued, than either *ruficapilla* or its Bahian representative, while there are slight suggestions of olive tips on some of the feathers in that area. Without a definite locality to indicate the proximity of *guira*, the possible influence of that species cannot be determined. A bird of uncertain sex, but presumably a male, from Jiquy, Bahia, has the pattern of *guira* but with a washed-out appearance due to the reduction of the intensity of yellow pigment throughout, but this is certainly not due to hybridism.

The combination of characters noted in these curious birds gives the impression of hybridization rather than true intergradation, and I prefer, therefore, to keep *guira* and *ruficapilla* specifically distinct.

One other fact of interest has come to light in the examination of *ruficapilla* and its Bahian representative, usually considered under the name *ruficeps*. Wied (1831, Beiträge zur Naturgeschichte von Brasilien, vol. 3, pt. 2, pp. 725-729) described *Hylophilus ruficeps* in great detail and remarked that he had observed it in the interior of Bahia and the neighborhood of Cabo Frio [Rio de Janeiro]. Allen (1889, Bull. Amer. Mus. Nat. Hist., vol. 2, no. 3, p. 221) identified the single specimen of the species in Wied's collection as *Nemosia ruficapilla* Vieillot and claimed for it the general locality "Province of Bahia," although there was no original label on the skin. Hellmayr (1915, Verhandl. Ornith. Gesellsch. Bayern, vol. 12, p. 131) discovered differences between examples from Bahia and Rio de Janeiro and applied Wied's name, *ruficeps*, to the Bahian population without, however, examining the type.

Unfortunately, the example from Wied's collection proves to belong to the larger and darker-headed form from Rio de Janeiro, and is most likely to have come from near Cabo Frio. The measurements given in the original description of *ruficeps* (wing, 2"5''; tail, about 1"10''), when con-

verted from the "Old French" standard,¹ show the wing as 65.5 mm. and the tail, 49.6, whereas the specimen shows the actual measurements to be 66.5 and 52, respectively. The published measurements and the dimensions of the specimen at hand are not thoroughly definitive, although agreeing better with those of the Rio population than with those of Bahian birds. Incidentally, the difference shown in the measurements of the tail as recorded and as shown by the example in hand may possibly be accounted for by the fact that the specimen, once mounted, has a projecting wire through the tail which may have obstructed the instrument used for measuring it, indeed, the figures were obtained from the mounted specimen and not from the freshly killed bird. Seventeen adult males of *ruficapilla* have the wing 64.1-69.5 (average, 65.9); tail, 49.8-56 (average, 52). Eight Bahian males have the wing 58-65.2 (average, 62.9); tail, 47-50.5 (average, 50).

Wied presumably had a young male, as well as an adult, which he described as duller and smaller than the adult. Possibly the smaller size may have been due, in part, to the young bird's having come from Bahia and not from Cabo Frio, although there is no assurance of it. Wied does not state where he collected the form, but merely where he observed it, so it is possible that he had only Cabo Frio specimens from which to prepare his description. The specimen now at hand is the only tangible evidence that remains beyond the published account.

Aside from the dimensions, the specimen has the dark head of the Rio de Janeiro population, obvious in comparison with both old and more recent examples of both forms. Its assignment to the more south-

¹ It is sometimes overlooked that there were several standards of measurement used by early ornithologists. Perhaps the most common on the Continent was the "Old French" inch, equivalent to 27.06 mm., but there was also the "Old Prussian" inch of 26.15 mm. that was used by some writers. The English inch, of course, is 25.4 mm. Unfortunately, no one has tabulated the various ornithologists who used the different standards, but it is important to realize that apparent discrepancies in recorded measurements of an early date may be due to a different scale than is supposed. A comparison of Wied's figures with the measurements of various of his existing types indicates that he used the "Old French" inch of 27.06 mm.

ern form is clear. Either of two courses, then, is open to the student. Hellmayr's virtual restriction of the type locality of *ruficeps* to Bahia can be accepted, even though it seems to have been based principally upon Allen's unsupported assumption that the existing specimen in Wied's collection came from that state, which is now untenable; or the identity of this specimen should be accepted as determining the application of the name *ruficeps* and the type locality altered to accord with the known range of the pertinent form. The latter course will necessitate the proposal of a name for the Bahian population, but it will accomplish two objects. The sole existing cotype of *ruficeps* will remain available as a criterion of that name (the converse situation could be the cause of continuing confusion), and the Bahian population will be provided with an unquestioned Bahian type specimen and restricted type locality, both desirable. Accordingly, I propose the following name for Bahian birds:

Hemithraupis ruficapilla bahiae, new
subspecies

TYPE: From Jaguaquara, central-eastern Bahia, Brazil; altitude 2000 feet. No. 245618, American Museum of Natural History. Adult male collected by Emil Kaempfer on September 1, 1927; original no. 6134.

DIAGNOSIS: Similar to *H. r. ruficapilla* from Espirito Santo and southern Minas Gerais south to Paraná, but the brown of the cap in the male sex lighter; wing and tail averaging longer.

RANGE: Known only from southeastern Bahia and as "Bahia" trade-skins.

DESCRIPTION OF TYPE: Top and sides of head Sanford's Brown × Raw Sienna; mantle near Warbler Green; uropygium Ochraceous-Tawny × Mars Yellow, passing into brighter yellow on the lower edge; upper tail-coverts a little lighter green than the back. Throat Russet × Tawny, changing to Mars Yellow × Raw Sienna on the breast; sides of neck Primuline Yellow; lower breast and upper abdomen Barium Yellow, becoming paler on the lower belly and grayer on the flanks;

under tail-coverts Citron Yellow. Wings dark brown with exposed outer margins (except of outermost primary) green like the back; inner margins and under wing-coverts white, with a yellow stripe along the carpal margin. Tail with median rectrices green; remainder brown with light green outer margins; shafts brown above, whitish beneath. Bill (in dried skin) with maxilla blackish brown, dull yellowish along the commissure toward the base; mandible dull yellowish. Feet dull blackish. Wing, 64.5 mm.; tail, 50; exposed culmen, 11; culmen from base, 14; tarsus, 17.

REMARKS: There appears to be more variation in the color of the throat and breast than in that of the crown, possibly because in skins the under side is more frequently exposed. On average, however, *bahiae* has a paler breast than *ruficapilla*.

The measurements of the series of adult males have been given under *ruficapilla*.

It may be added that the series now at hand furnishes the first definite localities for the species in the state of Bahia. I am grateful to Mrs. W. W. Naumburg for permission to select the type from the authentic material in the Kaempfer Collection.

SPECIMENS EXAMINED

H. g. guira.—

BRAZIL:

Bahia, Santa Rita [do Rio Preto], 1 (?);
Giguy, 1 ♂;
"Bahia," 1 ♂;
Goyaz, "Goyaz," 1 ♂; 1 ♀;
Ceará, Joazeira, 1 ♂;
Piauí, (Therézina Peoriano, Gilbues,
Corrente, Rio Juruena, Rio Julgá), 11 ♂,
3 ♀;
Maranhão, As Mangueiras, 5 ♂, 1 (?);
São João dos Patos, 1 ♀;
Rio Tocantins, Baião, 5 ♂, 3 ♀;
Mocajuba, 2 ♂, 2 ♀;
Cametá, 1 ♂;
Arumatheua, 1 ♀.

H. g. amazonica.—

BRAZIL:

Rio Tapajoz, Tauarý, 1 ♂ (type);
Aramanay, 1 ♂;
Piquiatuba, 2 ♂;
Caxiricatuba, 4 ♂;
Rio Madeira, Borba, 3 ♂, 2 ♀;
Igarapé Auará, 1 ♂.

H. g. nigrigula.—

BRAZIL:

Rio Negro, Igarapé Cacao Pereira, 1 ♂, 2 ♀.

FRENCH GUIANA:

Cayenne, 4 ♂, 2 ♀.

DUTCH GUIANA:

Paramaribo, 5 ♂, 2 ♀;
"interior," 1 ♂.

VENEZUELA:

(El Pilar, Colonia Tovar, east of Caracas,
El Limón, San Esteban Valley, Río
Neveri, and "Venezuela"), 2 ♂, 6 ♀.*H. g. roraimae*.—

VENEZUELA:

Roraima, 2 ♂, 2 ♀.

H. g. guirina.—

COLOMBIA:

Antioquia, 1 ♂;
near Honda, 1 ♂;
La Frijolera, 1 ♂;
Río Frio, 1 ♂, 1 ♀;
San Isidro, 1 ♂;
La Candela, 1 ♀;
Media Luna, 1 ♂;
"western Colombia," 1 ♂;
"Bogotá," 2 ♂.

ECUADOR:

Chimbo, 1 ♀.

H. g. huambina.—

COLOMBIA:

Loretayacu, 1 ♂;
"Bogotá," 4 ♂, 1 ♀.

ECUADOR:

Río Suno, 1 ♂;
below San José, 1 ♂;
Macas region, 1 ♂;
Napo, 1 ♂;
"Ecuador," 1 ♂;
"Archidona" (errore), 1 ♂;
Columbia, 1 ♂.

PERÚ:

Río Seco, 2 ♂;
Huarandosa, 5 ♂, 3 ♀;
Perico, 1 ♀;
San Felipe, 1 ♂;
Sarayacu, 1 ♂, 1 ♀;
Santa Rosa, Ucayali, 1 ♂.

BRAZIL:

Rio Madeira, Rosarinho, 1 ♂.

H. g. boliviana.—

BOLIVIA:

Todos Santos, 11 ♂ (including type), 3 ♀;
Mission San Antonio, 1 ♂;
Vermejo, 1 ♂;
Mapiri, 1 ♂, 1 ♀;
Prov. Sara, 2 ♂.

BRAZIL:

Matto Grosso, Chapada, 12 ♂, 8 ♀;
Urucum de Corumbá, 1 ♂;
Belvedere de Urucum, 2 ♂, 1 ♀.*H. g. fosteri*.—

PARAGUAY:

Sapucay, 5 ♂, 1 ♀;
east of Caaguassú, 2 ♂;
Colonia Independencia, 1 ♂, 1 ♀;
Zanja Moroti, 2 ♂, 2 ♀;
La Foncière, 2 ♂, 1 ♀;
Niu Poná, 1 ♂, 1 ♀.

BRAZIL:

Rio Grande do Sul, Sinimbú, 3 ♂;
São Paulo, Fazenda Cayoá, 1 ♂, 1 ♀;
Paraná, Foz de Iguaçu, 3 ♂, 4 ♀, 1 (?);
Guayra, 3 ♂, 5 ♀, 1 (?);
Porto Mendez, 1 (?).*H. r. ruficapilla*.—

BRAZIL:

São Paulo, Victoria, 1 ♂;
São Sebastião, 2 ♂, 2 ♀;
Paraná, Roca Nova, 1 ♂;
Tibagy, 1 (?);
Minas Gerais, Rio Caparão, 2 ♂;
Rio de Janeiro, Therezopolis, 1 ♀;
"Rio de Janeiro" (trade-skins), 10 ♂;
no locality [? = Cabo Frio], 1 ♂ (type of
ruficeps);
Espírito Santo, Baixo Guandú, 1 ♀;
Santa Barbara de Caparão, 1 ♀;
Lagôa Juparaná, 1 ♀.*H. r. bahiae*.—

BRAZIL:

Bahia, Tambury, 1 ♂;
Jaguaquara, 1 ♂ (type);
Boa Nova, 2 ♂;
"Bahia" (trade-skins), 5 ♂.*H. r. ruficapilla* × *H. g. fosteri*.—

BRAZIL:

São Paulo, Coredeiras, 1 ♂.

H. r. bahiae × *H. g. guira*.—

BRAZIL:

Bahia, Jequié, 1 ♂.

Hemithraupis flavicollis peruana
Bonaparte*Hemithraupis peruana* BONAPARTE, 1851, Rev.
Mag. Zool., ser. 2, vol. 3, p. 173—"Pérou"; type
lost.This form, with the yellow wing-bar, is
found in Perú only north of the Marañón,
whence it ranges northward across eastern
Ecuador to the eastern side of the Eastern
Andes of Colombia. Still farther east-
ward in Colombia, on the Venezuelan
boundary, *auricularis* occurs, but the meet-
ing ground of the two forms is still to be
learned.Peruvian records not shown by the ma-
terial in hand are from Pebas, Iquitos, and
possibly "E. Perú" and "Upper Amazon."South of the Marañón in northern Perú,
the records have been assigned heretofore
to *auricularis* (from the Caura River,
Venezuela), but I believe they represent an
undescribed subspecies which may be
known as follows:

Hemithraupis flavicollis sororia, new
subspecies

TYPE: From Chamicuros, Perú. No. 511173, American Museum of Natural History. Adult male collected August 15, 1867, by Edward Bartlett; original no. 2647.

DIAGNOSIS: Similar to *H. f. aurigularis* of southwestern Venezuela and adjacent parts of Brazil and Colombia, but males with throat paler yellow.

RANGE: Northern Perú south of the Marañón, in the Tropical Zone.

DESCRIPTION OF TYPE: Top of head, mantle, and scapulars dark brown (probably blacker when freshly killed); lower back a little deeper than Lemon Chrome; upper tail-coverts like the mantle. Sides of head like the crown but with the yellow of the throat invading the lower part of the lores and extending backward to the middle of the lower portion of the orbit; whole chin and throat near Lemon Chrome; breast and sides white with subterminal sooty lunules, strongest on the sides; belly white; flanks slightly grayish; thighs brown; under tail-coverts yellow like the throat. Wings and upper wing-coverts dusky brown with a small white speculum on the inner primaries at their bases; under wing-coverts white with a dusky patch at the bend of the wing. Tail sooty brown. Bill (in dried skin) with maxilla dark brown, a little paler along the commissure; mandible flesh, slightly brownish at tip; feet dark brownish. Wing, 66 mm.; tail, 48; exposed culmen, 11; culmen from base, 14.6; tarsus, 15.

REMARKS: Female not certainly distinguishable from that of *aurigularis*.

It might be suspected that the paler color of the throat in the Peruvian males of this form that are at hand is due to the age of the specimens. The dark color of the cap and mantle and of the wings and tail undoubtedly has faded and may have been much more blackish when the skins were fresh. Similar fading is easily demonstrable in good series of various other forms of varying dates of collection, although there is some variation in this particular, even in freshly collected material.

Similar fading of the yellow parts of the plumage is not comparably demonstrable; in fact, there is some possibility that the yellow color may deepen with age. In 45 adult males of *aurigularis*, seven are about 30 years older than the others and include the darkest-throated individuals. Only one of the fresher males is as light throated as the two Peruvian skins. An equally great difference in dates of collection is shown in the series of some other forms, and no fading of the yellow color is shown by the older birds. Consequently, I believe that the north-Peruvian birds here described are naturally paler throated than the southwestern Venezuelan population.

It may be mentioned that Taczanowski described the throat of males from the Peruvian area in question as lemon yellow. It is also true that the other two Peruvian forms of the species (*peruana* and *centralis*) have the throat similarly paler yellow than that of *aurigularis*. While not conclusive evidence in the present instance, the fact is suggestive. Finally, the range of *aurigularis* is, as far as can be determined, quite cut off from that of *sororia* and apparently interrupted by the interposition of *peruana* on the north bank of the upper Amazon. These remarks are detailed in view of the lack of Peruvian examples in fresh male plumage.

Peruvian records that are apparently assignable to *sororia* are from Yurimaguas, Jeberos, Chayavitas, Moyobamba, Río Ucayali, and Río Javari.

Hemithraupis flavicollis centralis
(Hellmayr)

Nemosia flavicollis centralis HELLMAYR, 1907, Novitates Zool., vol. 14, p. 350—Humaytá, Rio Madeira, Brazil; ♂; Amer. Mus. Nat. Hist.

A single male from Río Cosireni, southeastern Perú (one of two reported by Chapman, 1921, Bull. U. S. Natl. Mus., no. 117, p. 121) agrees well with the type and other specimens from western Brazil and northern Bolivia. The series of males does not show all of the characters ascribed to the subspecies, since the alar speculum is well developed and the chest only slightly more strongly barred than in *flavicollis*. The back is deeper black than in fresh examples

of the other forms, as far as I can determine, the throat is paler yellow than in *flavicollis* and *aurigularis*, being about as in *peruana*, and the size is relatively large, as in *insignis* and *melanozantha*.

I am not sure of the distinction of *melanozantha* from *insignis*, since I have fresh material only of *insignis* males and one female of *melanozantha*. The remainder of the material at hand consists of trade-skins. Some of these have been labeled "Rio-skin" which I suspect are "Bahia-skins" and vice versa. In any case, either with the arrangement as labeled or with what I consider the correct assignment, I can find no clear distinctions in the males. The females, as I have rearranged them, show that sex of *insignis* to be noticeably browner above than the more olivaceous *melanozantha*, but fresh material in series may discredit this apparent difference. Consequently, I give but tentative status to *melanozantha* and refer to it the Bahian material at hand.

SPECIMENS EXAMINED

H. f. flavicollis.—

FRENCH GUIANA:

"Cayenne," 1 ♂, 2 ♀.

BRAZIL:

Faro, 2 ♂.

H. f. hellmayri.—

BRITISH GUIANA:

Potaro Landing, 3 ♂, 1 ♀;

Tumatumari, 1 ♂.

H. f. aurigularis.—

VENEZUELA:

Suapure, 6 ♂ (including type), 3 ♀;

Nichare, 3 ♂;

Mt. Duida (Playa del Río Base, Campamento del Medio, Caño León, Pie del Cerro, Valle de los Monos, and Río Pescada), 12 ♂, 14 ♀;

Boca de Sina, 1 ♂;

Río Cassiquiare (Solano, mouth of Río Ocamo, Buena Vista, and Río Huayná), 14 ♂, 6 ♀, 1 (?).

COLOMBIA:

Río Uaupés, opposite Tahuapunto, 1 ♂, 2 ♀.

BRAZIL:

Río Uaupés (Tahuapunto and Iauarete), 3 ♂, 2 ♀, 1 (?);

Río Negro (San Gabriel, Santa Maria, Yucabí, and Tatú), 13 ♂, 7 ♀.

H. f. melanozantha.—

BRAZIL:

Bahia, Rio Gungogy, 1 ♀;

"Bahia," 4 ♂, 4 ♀.

H. f. insignis.—

BRAZIL:

Espirito Santo (Baixo Guandú and Lagoa Juparaná), 5 ♂, 1 (? ♀);

"Rio de Janeiro," 5 ♂, 1 ♀.

H. f. centralis.—

BRAZIL:

Humaytá, 1 ♂ (type);

Calamá, 1 "♂" [? = ♀];

Rio Roosevelt, "Camp 1," 1 ♂;

"Camp 21," 1 ♂;

Utariaty, 1 ♂; 1 ♀.

BOLIVIA:

Yungas, 1 ♂.

PERÚ:

Río Cosireni, 1 ♂.

H. f. sororia.—

PERÚ:

Chamicuro, 2 ♂ (including type), 1 ♀;

Orosa, 1 ♀.

H. f. peruana.—

PERÚ:

Pomará, 3 ♂, 2 ♀;

Apayacu, 2 ♂, 1 ♀;

mouth of Río Santiago, 1 ♂, 1 ♀;

mouth of Río Curaray, 1 ♂.

ECUADOR:

Río Suno, above Avila, 1 ♂;

lower Río Suno, 2 ♂, 2 ♀;

below San José, 1 ♂;

Chivinda, 3 ♂;

"Napo," 2 ♂.

COLOMBIA:

Florencia, 1 ♂;

"Bogotá," 3 ♂, 2 [? ♀].

H. f. albigularis.—

COLOMBIA:

Puerto Valdivia, 1 ♀;

"Bogotá," 2 ♂, 2 ♀.

H. f. ornata.—

PANAMÁ:

Boca de Cupe, Río Tuyra, 1 ♂.

Thlypopsis sordida chrysopsis (Sclater and Salvin)

Nemosia chrysopsis SCLATER AND SALVIN, 1880, Proc. Zool. Soc. London, p. 155—Sarayacu, eastern Ecuador; British Mus.

Thlypopsis amazonum SCLATER, 1886, Catalogue of the birds in the British Museum, vol. 11, p. 229—part; type from lower Ucayali, Perú; British Mus.

The Peruvian population is not divisible, nor is there any apparent distinction along the south bank of the Amazon as far as the eastern side of the Rio Madeira in Brazil.

Young birds of both sexes are green above, more yellowish on the head, and yellow beneath, with greenish margins on the wing and tail. Some of the colors of immaturity appear to be carried past the post-juvenile molt, both in this form and in

typical *sordida*, and there is thus an occasional specimen with a greenish patch on the occiput, possibly some green suffusion on the back, though the wings and tail are adult gray.

Peruvian records are from Río Perené, La Merced, lower Ucayali, Pebas, Nauta, Santa Cruz, and Tambillo.

The record from Tambillo is not entirely satisfactory, since it was based on a specimen said to be exactly like the type of *sordida* and hence must have been immature. Further discussion of this record is given below in the account of *T. inornata*.

Two specimens from Baião, Rio Tocantins, Brazil, belong to the buff-breasted *sordida sordida*. One of them (both birds are without indicated sex) has the entire under parts below the throat rather uniform buff, without any white on the belly. The other matches the least white-bellied examples from eastern Brazil and around to Bolivia. With only the two birds, it is impossible to say if a new form is likely to be involved. The locality is new to the record.

Study of birds from Bolivia, Argentina, and Brazil shows a slight decrease in size in the east-Brazilian part of the population as compared with the series from Matto Grosso, Argentina, and Bolivia. The difference is not striking. Fourteen males from the southwestern area have the wing 68–72 mm. in length; three males from Pernambuco have the wing 66–68; and six trade-skins from “Bahia” and “Rio de Janeiro,” presumably including some males, are 59–67. Similarly, 10 females from the southwest have the wing 64–70; two from eastern Brazil, 64 and 66.5. The smallest trade-skins from the east show that some of the eastern birds, probably females, may go as low as 63.5. The relatively few sexed specimens from the eastern region should be supplemented by much more material before there will be assurance that there is a positive difference in size in this region. I can find no clear color characters to differentiate the birds from the two areas. If separable, the name “*fulvescens*” (Strickland, 1844, Ann. Mag. Nat. Hist., vol. 13, p. 420—“Brazil”) may be available for an eastern form.

In this connection, it may be stated that the two skins from the Rio Tocantins are relatively large, having the wings 67.2 and 69 mm., respectively. These measurements would place them in closer association with the topotypical *sordida* than with an eastern form.

SPECIMENS EXAMINED

T. s. sordida.—

BOLIVIA:

Mission San Antonio, 1 ♂, 3 ♀;
Todos Santos, 4 ♂, 4 ♀, 1 (?);
Prov. Sara, 1 ♂;
Monos, 1 ♀.

ARGENTINA:

Tafi Viejo, 3 ♂, 1 ♀;
Tafi trail, 2 ♂;
San Vicente, 1 ♂;
above San Pablo, 1 ♀.

BRAZIL:

Chapada, 8 ♂, 7 ♀;
Agua Blanca de Corumbá, 1 ♀;
Pernambuco, Palmares, 1 ♂, 1 ♀;
Bello Jardim, 1 ♂, 1 ♀;
Brejão, 1 ♂;
Garanhuns, 1 (?);
Minas Gerais, Rio Caparaó, 1 ♂, 1 (?);
Piahy, Extremas, 1 ♀;
Parnagua, 1 ♀;
Ceará, Qujada, 1 ♀;
Bahia, Bahia, 1 ♀;
Jaguaquara, 1 (?);
“Bahia,” 3 (?);
“Rio de Janeiro,” 3 (?);
Rio Tocantins, Baião, 2 (?).

T. s. chrysopsis.—

ECUADOR:

Mouth of Lagarto Cocha, 1 ♂.

PERÚ:

Puerto Indiana, 3 ♀;
mouth of Río Curaray, 4 ♂, 2 ♀;
Lagarto, 2 ♂, 2 ♀;
Santa Rosa (Ucayali), 1 ♂;
Chanchamayo Valley, 1 ♂;
San Ramón, 1 ♂.

T. s. orinocensis.—

VENEZUELA:

Capuchín, 1 ♂;
[Isla] El Fraile, 1 ♀;
Altigracia, 1 ♂, 1 ♀.

Thylopsis inornata (Taczanowski)

Nemota inornata TACZANOWSKI, 1879, Proc. Zool. Soc. London, p. 228—northern Perú = Tambillo, Dept. Cajamarca; ♂; Warsaw Mus.

Lomo Santo, 1 ♂, 1 ♀; Perico, 1 ♂, 2 ♀; Saucos, 1 ♀; Jaén, 2 ♀; San Ignacio, 3 ♂, 1 ♀, 2 (?).

This species is wholly Peruvian and restricted to a limited part of the country.

There are some features that suggest close relationship to *T. sordida*, but both birds are recorded from Tambillo and more evidence is needed. The Tambillo record of *sordida* [*chrysopsis*] was based on an immature skin which, however, Taczanowski (1884, *Ornithologie du Pérou*, vol. 2, p. 509) said was exactly like the type (also an immature specimen), so confusion with *inornata* seems hardly likely though not impossible. Taczanowski's description of "*sordida*" is a virtual transcription of the original characterization of that Bolivian form, from which the Tambillo specimen is said to differ only by somewhat more extensive rufous coloration on the sides of the crown. Presumably the belly was white and the anterior under parts extensively yellow which is not the case in *inornata*, although there may be a slight tendency in that direction as noted below. The locality, Tambillo, is some distance away from the nearest place where *sordida chrysopsis* has been found, although it is in the heart of the range of *inornata*. Until it is certain, however, that there is some error in the record, the coexistence of *sordida chrysopsis* and *inornata* at Tambillo must be accepted.

There are various points of resemblance between *sordida* subsp. and *inornata*. The proportions are much the same, including the heavy bill which serves at once to distinguish these two species from the other Peruvian congeners. The nearest approach is in *fulviceps* which does not occur in Perú. At any rate, I should place *sordida* and *inornata* immediately adjacent without the interposition of *fulviceps* as Hellmayr has arranged matters.

The full cinnamon buff under parts of *inornata* are reflected in extreme examples of *s. sordida* such as the specimen from the Rio Tocantins discussed on a previous page under *sordida chrysopsis*. The white belly of most *sordida sordida*, on the other hand, is indicated by extreme examples of *inornata* in which that area is distinctly paler than the flanks though not pure white except basad of the pale buff tips of the feathers. Occasional examples of *sordida* have the rufous cap as dark as it is in *inornata*, but there is always a strong yellow-

ish coloration on parts of the sides of the head and on the throat which does not appear in adult *inornata*. Nevertheless, two immature examples of *inornata* have a noticeably yellow tinge on the throat which is suggestive.

These two young birds agree well enough with the description given by Taczanowski (1884, *loc. cit.*) of the female plumage, except that there is no mention of a yellowish-tinged throat. One of the birds in hand is a female and the other is without given sex, but both are very slightly more lax plumaged than adults and may be in their "first-winter" dress. Five other birds before me, sexed as females, are like the adult males, from which I judge that Taczanowski's female was not adult.

To make matters more confusing, a male specimen with very fluffy plumage and only half-grown bill has the full pattern of the adult male, with the whole top of the head rufous (lighter than in the adult), the throat and breast pale cinnamon buff, and the belly quite pale buff, inclined to whitish. This bird is obviously younger than the two immature individuals discussed above, but it is difficult to imagine a transition from its coloration to that of the two older immature birds. Taczanowski (*loc. cit.*) describes a young male as much like the bird he thought was an adult female—in other words with a large coronal area of olive, only tinged with rufous, and with a strongly marked superciliary stripe. I have no other equally young specimens of any of the species of the genus, but in none of the immature examples of any of them is there such close similarity to the adults. I judge, therefore, that the present young male is abnormally "advanced" in its coloration.

Other Peruvian records of *inornata* are from Tabaconas, Bellavista, Tambillo, Callacate, Hacienda Limón, and Río Utubamba. The last named is the only locality east of the Marañón. Chapman's record from San Miguel Bridge, Urubamba Valley, was based on a misidentified immature example of *T. ornata macropteryx*.

Thlypopsis ornata media Zimmer

Thlypopsis ornata media ZIMMER, 1930 (Dec. 10), Field Mus. Nat. Hist., zool. ser., vol. 17, p. 452—Culleui, Río Marañón, Perú; ♀; Chicago Nat. Hist. Mus.

This form was originally described in comparison with certain material to which I was given access which had been misidentified as *T. o. macropteryx* but which was in reality *T. pectoralis*. In the absence of authentic *macropteryx*, the error was not detected at the time. Consequently the characters given for the separation of *media* from *macropteryx* are non-existent, although they serve for the distinction of both *media* and *macropteryx* from *pectoralis*.

The question then arises as to the separation of *media* and *macropteryx*. I have only one adult *macropteryx*, and in coloration it does not differ from typical *ornata* or the birds I called *media*. It is, however, larger than any female of *media*, and the recorded measurements of male *macropteryx* are greater than those of the same sex of *media*, so it seems possible to maintain the two forms as distinct on the basis

teryx that is, in part, filled by the allied *T. pectoralis* which may possibly prove to be a representative form of the same species. The matter is discussed further under *pectoralis*.

As will be noted from the localities listed for material examined, *media* occurs on the western side of the Western Andes as well as in the Marañón Valley. Records are from Tambillo, Cutervo, and Paucal.

Thlypopsis ornata macropteryx

Berlepsch and Stolzmann

Thlypopsis ornata macropteryx BERLEPSCH AND STOLZMANN, 1896, Proc. Zool Soc. London, p. 345—Maraynioc, Perú; ♂, ♀ cotypes in Warsaw Mus. (? and Amer. Mus. Nat. Hist.).

The distinction of this form from *media* is discussed under *media*.

This is apparently a rare bird in collections. Numerous good collectors have visited the Maraynioc region, but Kalinowski's original specimens seem to remain the only examples known with the exception of a young bird of uncertain sex from the Urubamba Valley erroneously recorded as *T. inornata* (Chapman, 1921, Bull. U. S. Natl. Mus., no. 117, p. 121).

MALES

	WING	TAIL	CULMEN FROM BASE	TARSUS
<i>ornata</i>	55-61.5	44-50.5	13-14	18-20
<i>media</i>	64-68	49-55	13.5-14.5	19-22.2
<i>macropteryx</i>	67.7-71.5	56.5-61	—	20.5-21.7

FEMALES

	WING	TAIL	CULMEN FROM BASE	TARSUS
<i>ornata</i>	56-60	43-46	12.5-14	20-21
<i>media</i>	62-64	47-51	14-14.5	20-20.5
<i>macropteryx</i>	66-70	54	14.9	21

of size alone. A series of *macropteryx* might show some additional feature, but *macropteryx* appears to be extremely rare in collections, and no other material is available except a young bird from the Urubamba Valley which is useless for the purpose.

The above figures show the differential in size among the three forms. I accept the measurements given by Berlepsch and Stolzmann for additional *macropteryx*.

An added reason for the recognition of *media* is that there is an apparent hiatus between the ranges of *media* and *macropteryx*.

One of Kalinowski's birds, now before me, is labeled "typus" on the original label and "co-type" on the label of the Rothschild Museum. It is a female, collected on January 7, 1893, whereas Berlepsch and Stolzmann do not list this date for any of the five examples on which they based their description of *macropteryx*. Since they presumably had the entire Maraynioc collection of Kalinowski before them, the omission of this date may have been unintentional. In any case, the bird

is a positive topotype and probably a co-type as labeled.

***Thlypopsis pectoralis* (Taczanowski)**

Nemosia pectoralis TACZANOWSKI, 1884, Ornithologie du Pérou, vol. 2, p. 508—Acancocha, Perú; ♀; Warsaw Mus.

The similarity of this form to the *ornata* group is so great that it would be easy to consider it no more than a subspecies were it not for an apparent overlapping of ranges. Both *pectoralis* and *o. macropteryx* occur in the highlands of the Junín region of central Perú, and although *pectoralis* has been found only in the more northern part of this area and *macropteryx* more to the southward, both have been found at Auquimarca which is a little north of the most southern locality for *pectoralis*. Until more is known of the precise local distribution of both forms, it will be necessary to keep them specifically distinct.

Thlypopsis pectoralis, in spite of its close resemblance to *macropteryx*, is readily distinguishable in all specimens examined by having the rufous color of the head deeper in tone, without the yellowish element present in *macropteryx*, although one young bird shows a slight tinge of yellow on the throat (not so strong as in young *ornata media*). The flanks are grayish olive instead of rufous, although there is a suggestion of rufescence in several specimens. The white area of the belly is broader than in the *ornata* group, and the rufous chest is more broadly defined from the white belly; also the definition between the rufous cap and the olive gray back is somewhat sharper than in the forms of *ornata*. For measurements of *macropteryx* I am dependent on Berlepsch and Stolzmann's original account of that form, except for a single female (? cotype), and it appears that *pectoralis* agrees fairly closely with *macropteryx* in the dimensions of tail, bill, and tarsi but has a shorter wing, on average, in closer approximation to that of *o. media*. It is thus, in a sense, intermediate in dimensions between *o. macropteryx* and *o. media* as its intermediate range would suggest if it were conspecific.

The sole record of a member of the *ornata* group from Auquimarca is that made

by Jelski and recorded by Taczanowski (1874, Proc. Zool. Soc. London, p. 515), based on a male and a female. He maintained this assignment at the same time that he described *pectoralis*, and it is difficult to prove an error without an examination of the specimens, now presumably destroyed. An error in the labeling of the material is equally difficult to determine. If future investigation should show that *macropteryx* is not of regular occurrence at Auquimarca, the labeling of Jelski's specimens could be questioned with some justice, and *macropteryx* and *frontalis* considered as geographically representative. In the meantime, their specific separation must be maintained.

SPECIMENS EXAMINED

T. o. ornata.—

ECUADOR:

Ibarra, 1 ♀;
Mindó, 1 ♂;
Intac, 1 ♀;
Huigra, 3 ♂¹;
Chunchi, 2 ♀¹;
Cayandeled, 1 ♀².

T. o. media.—

ECUADOR:

Taraguacocha, 1 ♂;
Loja, 1 (?)¹.

PERÚ:

Taulis, 1 ♂;
Seques, 1 (?)¹;
Levanto, 1 ♀;
San Pedro, 1 ♂, 2 ♀, 1 ♂¹, 1 ♀²;
Leimebamba, 1 ♂, 3 ♂¹, 1 ♀¹;
Lluy [Luy], 1 ♂¹;
Chira, 1 ♂¹;
Yánac, 1 ♂¹;
Cochabamba, Dept. Libertad, 1 ♂¹;
Porculla, 1 ♂¹;
Culleui, 1 ♀ (type)³.

T. o. macropteryx.—

PERÚ:

Maraynioc, Pariayacu, 1 ♀ (? cotype);
San Miguel, Urubamba Valley, 1 (?)¹.

T. pectoralis.—

PERÚ:

Chipa, 1 ♂;
Rumicruz, 3 ♂, 2 ♀, 1 (?)¹;
Auquimarca, 3 ♂¹, 1 ♀¹;
above Huánuco, 5 ♂², 2 ♀³;
above Panao, 1 ♀³.

¹ Specimens in Academy of Natural Sciences of Philadelphia.

² Specimens in United States National Museum.

³ Specimens in Chicago Natural History Museum.

Thlypopsis ruficeps (D'Orbigny and Lafresnaye)

E[uphonia] ruficeps D'ORBIGNY AND LAFRESNAYE, Mag. Zool., vol. 7, cl. 2, "Syn. Av.," [1], p. 30—Yuracares, Bolivia [= near Palca, Prov. Ayopaya (between Cochabamba and Incasivi)]; ♂; Paris Mus.

Oconeque, 1 ♂; Santo Domingo, 1 ♂, 1 ♀, 1 (?) ; Marcapata, 2 ♂, 1 ♀; Limbani, 1 ♂, 1 ♀; Inca Mine, 1 ♂, 1 ♀; Idma, 1 ♂; Santa Rita, Urubamba, 2 ♂, 1 ♀; Torontoy, 1 ♀; San Miguel, 1 ♂; Calca, 1 ♀.

There is no observable distinction between this series and Bolivian specimens, and northwestern Argentine birds are in similar agreement. There is some individual variation in the depth of color on the head, the extent of invasion of the sides of the throat by the rufescence of the head, and the invasion of the occiput by the green of the mantle. I am not certain of the full significance of the last-named feature. Several males that show the character of green occiput are in process of molt in which the area is becoming rufous like the crown, but three females and one male, none of which is molting or showing obvious signs of immaturity, have this characteristic well marked. Another female has the occiput green with only a slight tinge of rufescence at the tips of the feathers. Eight females are indistinguishable from the males. Young birds (? first winter) have the whole top of the head green, sometimes with a slight golden tinge and with a yellow or golden superciliary. Perhaps the birds with the green occiput are in an intermediate stage peculiar to the second year.

One male from Limbani (the apparently adult male with the green occiput) is further distinguished by having a suggestion of a rufous necklace at the lower border of the throat. The rufous color of the crown is at the maximum depth of saturation, adding weight to the assurance that this bird is beyond its first year.

Additional localities of record in Perú are Huaynapata, Quispicanchis, and Uruhuasi ("Chuhuasi").

Piranga rubriceps (G. R. Gray)

Piranga rubriceps G. R. GRAY, 1844, The genera of birds, vol. 2, p. 364, pl. 89, lower fig.—no locality; type a "Bogotá-skin" in the British Mus.

Piranga rubriceps rufistigmata LONNBERG AND RENDAHL, 1922, Ark. Zool., vol. 14, no. 25, p. 86—above Baeza, eastern Ecuador; Stockholm Mus.

San Pedro, 1 ♂, 1 ♀; La Lejia, 5 ♂, 1 ♀.

I can find no differences in birds from Ecuador, Colombia, and northern Perú to justify the recognition of "*rufistigmata*."

Other Peruvian records are from Cuztervo and Cumpang, while Chira is to be added from the collections of the Academy of Natural Sciences of Philadelphia.

Piranga leucoptera ardens (Tschudi)

Ph[oenisoma] ardens TSCHUDI, 1844, Arch. Naturgesch., vol. 10, no. 1, p. 287—central Perú; Vitoc suggested by Hellmayr, 1936; type in Mus Neuchâtel.

This subspecies ranges from the Cochabamba region of Bolivia northward through Perú to southern Ecuador and on the western side of the Andes to southern Colombia. A single male from Sabanilla furnishes the only record from the eastern side of the mountains in Ecuador.

Throughout this range, there appears to be little distinction, although the Ecuadorian birds have the lower wing-bar a little wider, in some cases, than the average Peruvian specimen.

Still farther north, especially in northern Venezuela, there is developed a noticeably wider wing-bar that is sufficiently constant to warrant the taxonomic separation of the northern population which may be known as described below.

Peruvian records of *ardens* are from Achamal, Chirimoto, Huambo, Vista Alegre, Huachipa, Garita del Sol, Río San Miguel, and Huaynapata.

Piranga leucoptera venezuelae,
new subspecies

TYPE: From Galipán, Cerro de Avila, Venezuela. No. 510292, American Museum of Natural History. Adult male collected December 30, 1913, by S. M. Klages; original no. 1579.

DIAGNOSIS: Similar to *P. l. ardens* of Perú, Ecuador, northwestern Bolivia, and

(at least) southern Colombia, but with the white lower wing-bar broader, colors not certainly different.

RANGE: Northern Venezuela from the states of Lara and Falcón eastward to Sucre and Monagas; doubtfully across central Colombia to the Cauca Valley.

DESCRIPTION OF TYPE: General color Scarlet Red; lores, malar apex, a narrow post-nasal bar, and a narrow circumocular ring black; rump a little brighter than the top of the head; mantle a little duller with the feathers away from the midline showing an increasing amount of subterminal black which entirely replaces the red on the outermost feathers and the scapulars. Remiges black with narrow white inner margins; greater upper wing-coverts black with a broad white tip on the outer web (as much as 10 mm. in length along the shaft on some of the inner feathers but narrower on the outer ones), and crossing the shaft to the outer web near the tip; median coverts broadly (about 8 mm.) tipped with white on both webs; lesser series without white; under wing-coverts white except for area adjacent to the carpal margin. Tail black. Bill and feet (in dried skin) blackish; mandible basally slaty. Wing, 75 mm.; tail, 59; exposed culmen, 14; culmen from base, 17; tarsus, 19.

REMARKS: Females are much like those of *ardens*, but the yellow of the under parts is usually lighter and clearer, and the top of the head reaches a somewhat brighter extreme of yellow coloration, but the difference is not constant. As with the males, the width of the lower wing-bar is the best character, but even that is not so satisfactory a criterion as it is in the males.

There is some suggestion of difference in coloration between *ardens* and *venezuelae*, but it is too inconstant to be included in the diagnosis. In the series of *venezuelae* there are proportionately more males of a light or rosy red than in the series of *ardens* in which there are relatively more deeply colored males. The females similarly show a tendency toward lighter coloration in the north and darker in the south. It would be impossible, however, to allocate any large proportion of the specimens on this basis.

Colombian birds are not assignable to this form or *ardens* without some question. Additional material will be needed to settle the question. Two adult males labeled, respectively, "Colombie" and "Bogotá," and a subadult male also labeled "Bogotá," although none of the three is of the typical "Bogotá-make," are certainly referable to *venezuelae*. They have the appearance of Salmon's skins from Antioquia and may have come from that region. Two adult males and a female from Ricaurte and a female from east of Palmira are somewhat equivocal, but the two Ricaurte males are closer to *ardens* than to the new form and their assignment to *ardens* is further recommended by the geographical position of the locality. The female from east of Palmira is tentatively assigned to *venezuelae* in view of the probable occurrence of that form farther north in the Cauca Valley. Larger series of authentic males may necessitate the revision of this assignment.

Two presumed females, labeled "Bogotá," are even more uncertain. One of them has the grayish rump of typical *leucoptera* and may be assigned to that form in spite of the locality indicated on the label, since it is not a "Bogotá-skin" and the origin is, therefore, most uncertain. The other example is of the ordinary "Bogotá-make" and, although it has a relatively narrow wing-bar, it can be matched by north-Venezuelan examples of the same sex.

Ecuadorian specimens of both sexes are, as might be expected, closest to *ardens*, although some intermediacy is apparent. Most puzzling are two males from Mt. Roraima, Venezuela. Both birds show some traces of immaturity and have the plumage rather abraded, so, although the lower wing-bar appears to be relatively narrow, it cannot be taken as convincing evidence. Fortunately, I have been able to examine two males from Mt. Ptari-tepui, in the collection of Mr. William H. Phelps, and have found more evidence of value than in the Roraima specimens. One of the Ptari-tepui birds shows traces of immaturity, but the other is fully adult and has the lower wing-bar as broad as in north-Venezuelan examples. I have no

hesitation, therefore, in referring the Ptari-tepui birds to *venezuelae* to which the Roraima examples quite certainly also belong. This whole southeast-Venezuelan population is isolated from the north-Venezuelan or east-Colombian populations by the llanos of the Orinoco Valley, and subspecific distinction would not have been surprising. I am unable to discover any basis for such distinction in the meager material available at present.

SPECIMENS EXAMINED

P. l. leucoptera.—

MÉXICO:

(Orizaba and Jalapa), 2 ♂.

GUATEMALA:

(Chimoxan, Finca Cipres, Finca Carolina, Finca Sepacuite, San Felipe, and "Guatemala"), 20 ♂, 8 ♀, 3 (?).

NICARAGUA:

(Ocotul, Quilali, San Rafael del Norte, and San Juan, Talpaneca), 8 ♂, 1 ♀.

P. l. latifasciata.—

COSTA RICA:

(Monte Redondo, Guayabo, Bonilla, Navarro, Navarro, Aquinares, Estrella de Cartago, Azahar de Cartago, and "Costa Rica"), 13 ♂, 3 ♀, 4 (?).

PANAMÁ:

(Boquete, Chiriquí, Veraguas, Cerro Flores, and Jicarón Is.), 13 ♂, 2 ♀, 1 (?).

P. l. venezuelae.—

COLOMBIA:

East of Palmira, 1 ♀;

"Colombie," 1 ♂;

"Bogotá," 1 (? ♂), 1 (? ♀).

VENEZUELA:

Galipán, 2 ♂ (including type), 2 ♀;

El Limón, 3 ♂;

Loma Redonda, 1 ♂, 1 ♀;
Cumbre de Valencia, 1 ♂, 1 ♀;
Valley of Santa Ana, 1 ♂;
Campos Alegre Valley, 1 ♂, 2 ♀;
Los Palmales, 2 ♂, 1 ♀;
Los Dos Ríos, 1 ♂;
Quebrada Seca, 5 ♂; 1 ♀;
San Antonio, Bermúdez, 1 ♂;
Galipán, 2 ♀;
Caripe, 1 ♀, 1 ♀¹;
El Cerrón, 2 ♂¹, 4 ♀¹;
El Cogollal, 1 ♂¹;
Altamira, Barinas, 7 ♂¹, 1 ♀¹, 1 (?¹)¹;
Cubiro, Lara, 1 ♂¹;
San Luís, Falcón, 1 ♂¹, 5 ♀¹;
Curimagua, Falcón, 7 ♂¹;
San José de las Caracas, 2 ♀¹;
La Sabana, Perijá, 1 ♀¹;
Quebrada Bonita, Anzoategui, 2 ♀¹;
El Peonía, Anzoategui, 1 ♀¹;
San Juan, 1 ♀¹;
Colonia Tovar, 1 ♀¹.

P. l. ardens.—

COLOMBIA:

Ricaurte, 2 ♂, 1 ♀.

ECUADOR:

Cocó, 1 ♂, 1 ♀;

Zaruma, 1 ♂;

Paramba, 1 ♂;

Nanegal, 1 ♂.

PERÚ:

Utcuyacu, 2 ♂;

Chaupe, 1 ♂;

Cushi Libertad, 1 ♀;

Río Huacamayo, 1 ♀;

Eneñas, 1 ♂²;

Río Jelashte, 1 ♂², 1 ♀²;

San Ignacio, 1 ♂², 1 ♀².

BOLIVIA:

Palmar, Cochabamba, 1 ♀².

¹ Specimens in collection of William H. Phelps, Caracas.

² Specimens in Academy of Natural Sciences of Philadelphia.

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PLEISTOCENE REMAINS OF *PANTHERA TIGRIS* (LINNAEUS) SUBSPECIES FROM WANHSIEN, SZECHWAN, CHINA, COMPARED WITH FOSSIL AND RECENT TIGERS FROM OTHER LOCALITIES

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INTRODUCTION

The remains of the tiger dealt with in the present paper form part of a collection of fossil mammals secured for the American Museum of Natural History by the late Dr. Walter Granger during the winters of 1921-1922, 1922-1923, and 1925-1926. The exact locality is Yen Ching Kao, Wanhsien, eastern Szechwan. A preliminary description of part of the collection has been given by Matthew and Granger (1923), who then considered the fauna to be probably upper Pliocene. In this paper the specimens were mentioned under the head *Felis* aff. *tigris* Linnaeus. They were sent to the Leiden Museum of Natural History in 1937 at the request of Dr. L. D. Brongersma who had made a study of the fossil cats from Java in the Dubois collection (Brongersma, 1935). The feline fossils fortunately survived the war.² They consist of cranial remains, including an almost complete but crushed skull (figured by Matthew and Granger, 1923, p. 585, fig. 16), and of limb and foot bones: a humerus, two metacarpals, a tibia, an astragalus, two calcanea, and five metatarsals.

For comparison I used a series of recent tiger and lion skulls and skeletons, and the fossil tiger remains from Java collected by Eugène Dubois, now in the Leiden Museum.

The age of the Chinese specimens is now regarded as lower Pleistocene. As Dr. G. G. Simpson kindly wrote me, the cir-

cumstances of occurrence and of collecting do not guarantee that the Yen Ching Kao fauna is absolutely unified as to age. He is inclined to think that the bulk of the fauna is Pleistocene, although it is possible that a few Pliocene elements (*Stegodon*, *Chalicotherium*) are included.

Brongersma's paper assembles previous records of fossil tigers. Matthew and Granger's paper, however, is mentioned as the sole reference to the fossil tiger of China. Its synonymy is³:

Panthera tigris (Linnaeus) subspecies

? *Felis*, KOKEN, 1885, Palaeont. Abhandl., Berlin, vol. 3, pt. 2, p. 106, pl. 6, fig. 3 (?Y, ?A).

Felis aff. *tigris*, MATTHEW AND GRANGER, 1923, Bull. Amer. Mus. Nat. Hist., vol. 48, p. 584, fig. 16 (W); YOUNG, 1932, Bull. Geol. Soc. China, vol. 11, no. 4, p. 388 (W); YOUNG, 1939, *ibid.*, vol. 19, no. 2, p. 320 (W).

F[elis] aff. *tigris*, PEI, 1934, Palaeont. Sinica, ser. C, vol. 8, pt. 1, p. 132 (W).

Felis acutidens, ZDANSKY (*partim*), 1928, Palaeont. Sinica, ser. C, vol. 5, pt. 4, p. 48, pl. 4, figs. 6-11 (C).

Felis acutidens, YOUNG, 1932, Bull. Geol. Soc. China, vol. 11, no. 4, p. 388 (C).

Felis sp., YOUNG, 1932, Bull. Geol. Soc. China, vol. 11, no. 4, p. 387, fig. 5 (Y).

Felis cf. *tigris*, PEI, 1934, Palaeont. Sinica, ser. C, vol. 8, pt. 1, p. 130, pl. 23, fig. 3, pl. 24, figs. 1, 6, text figs. 40A, 41A, 42 (C); TEILHARD DE CHARDIN, 1936, Palaeont. Sinica, ser. C, vol. 7, pt. 4, p. 15 (C).

F[elis] tigris, PEI, 1934, Palaeont. Sinica, ser. C, vol. 8, pt. 1, p. 132 (A).

Felis tigris, PEI, 1936, Palaeont. Sinica, ser. C, vol. 7, pt. 5, p. 52 (C); TEILHARD DE CHARDIN AND YOUNG, 1936, Palaeont. Sinica, ser. C, vol. 12, pt. 1, p. 9, pl. 1, figs. 1-2, pl. 2, figs. 1-2, text figs. 1-2 (A).

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² During an air raid in December, 1944, some bombs hit the building in Leiden where the main part of the Dubois collection was stored. Many specimens, especially of proboscideans and deer, were lost; *Pithecanthropus* was saved.

³ A, Anyang; C, Chou Kou Tien; W, Wanhsien; Y, Yunnan.

? *Felis youngi*, PEI, 1934, *Palaeont. Sinica*, ser. C, vol. 8, pt. 1, p. 133, pl. 23, figs. 1, 4, text fig. 40B (C).

Loukashkin (1936, 1937) records *Panthera tigris longipilis* (Fitzinger) from the Pleistocene of northern Manchuria, but unfortunately neither describes nor figures his specimens.

The skull in the Wanhsien collection of the American Museum of Natural History (A.M.N.H. No. 18624, fig. 1) was found with the lower jaw *in situ*. The specimen had been subjected to a crushing force which acted especially in the middle of the skull. The right nasal and maxillary are placed on a higher level than the left, both zygomatic arches are fractured and displaced, the brain case is distorted, and the right bulla is missing. The right mandibular ramus is fractured posteriorly and displaced inward and upward.

It is impossible to reconstruct the exact shape of the anterior narial orifice and to establish whether the nasals are wedged in between the frontals posteriorly beyond the maxillaries or not, but there remain other characters which show that the specimen is a tiger. The interval between the bulla and the postglenoid process is greater than in a lion's skull (cf. Haltenorth, 1936, p. 53, figs. 36, 71), and the orbital margin of the malar is more concave (*ibid.*, figs. 38, 63). I do not agree with Haltenorth as to the validity of the shape of the malar-maxillary suture as a specific character, although the shape of that suture in the Wanhsien skull is perfectly in accord with that given by Haltenorth as typically tiger-like.

The shape of the lower edge of the mandibular ramus is fully consistent with that of the tiger, being slightly concave between the symphysis and the angular process. This is well shown on the right side; the swelling on the left ramus below the carnassial shown in Matthew and Granger's figure (1923, p. 585¹) is the result of crushing.

The incisor dentition is complete, but the tips of the left canines have been broken off. P² is missing on both sides, and P³ is

damaged. The upper carnassial is beveled away on the inner side. The lower teeth are complete. Notes on the dentition of this and the following specimens are given below.

The second specimen (A.M.N.H. No. 18737) is the anterior portion of a skull with the lower jaw *in situ*. That this, too, is a tiger is evident from the shape of the anterior narial orifice (fig. 2) which is narrowed below instead of being regularly curved from side to side (cf. Boule, 1906, p. 71, figs. 3-4). Of this specimen only the right P⁴ is completely preserved. The canines are larger than in the foregoing skull.

A.M.N.H. No. 18741 comprises a fragment of the left maxillary with P³, P⁴, and the alveolus of M¹. The carnassial is tiger-like; the protocone is well developed. There is also a portion of the left ramus of a mandible with P₃-M₁. The lower border is straight.

A.M.N.H. No. 18740 is the left ramus of a lower jaw with the alveoli of the incisors, the entire canine, and the full set of permanent teeth. Only the lower portion of the masseteric fossa is preserved. The lower edge of the ramus shows a slight bulging below M₁. Recent tigers may show the same peculiarity (Leiden Museum, Reg. No. 315, two specimens). A mandible from Chou Kou Tien was described by Pei (1934, p. 133) as a new species, *Felis youngi*, on account of the gently convex lower border and the longer symphysis and larger size as compared to *Panthera tigris* (Linnaeus). In the present specimen the symphysis is even longer than in Pei's type specimen (74 mm. against 71.4 mm. in the Chou Kou Tien jaw), and the convexity of the lower edge of the ramus, although more anterior and more strongly marked than in our specimen, is occasionally found in the tiger, too (Haltenorth, 1936, p. 54). I shall return to the question of size below.

A.M.N.H. No. 18738 includes five specimens, all of young individuals:

1. Fragment of left maxillary with dc, C erupting, alveolus of P², dm³, and erupting P⁴.

¹ I removed the piece of bone adhering to the mandible below the anterior portion of the masseteric fossa, as not belonging to the skull.

2. Similar fragment, but of the right side, and without dc.

3. Small fragment of right maxillary with dc, C erupting, and P².

4. Right ramus of mandible with central incisors just in place, I₃, C, and erupting M₁.

5. Small anterior fragment of right lower jaw with C in alveolus, dm₃, dm₄, and the germ of the carnassial.

The incisors in the two skulls have not been freed of matrix behind, and offer no interesting points for description. In fact, since Koken's (1885) figure of an incisor of uncertain origin which Schlosser (1903, p. 39) determined as an I³, no attention has been paid to the incisors of Chinese tigers.

The upper canines possess two longitudinal grooves on the outer surface. Posteriorly they present a longitudinal ridge on the enamel. Of the two outer grooves the anterior is stronger than the other. The grooves do not extend upward to the margin of the enamel, but the posterior ridge does. This is exactly what we find in *Panthera tigris* (Linnaeus). Zdansky (1928, p. 48) observed a posterior ridge on an upper C which he identified as "*Felis acutidens* sp. n.," and states that among recent felines this ridge is to be found only in *Neofelis nebulosa* (Griffith).

The lower canines also are indistinguishable in shape from those of the recent tiger, having an outer and an inner longitudinal groove and a medio-posterior longitudinal ridge.

P² has not previously been described from China. It can be studied only in the juvenile specimen (A.M.N.H. No. 18738, 3 of the preceding list). The basal plane is subtriangular, the angle between the inner and posterior sides is approximately a right angle, and the posterior side is about three-fourths as long as the inner. The paracone is low and elongated. The metacone is merely a ridge behind it and descending less steeply than the protocone. The cingulum is present only along the inner and posterior inner margins.

In recent specimens P², if present, has exactly the same shape. Variations, however, are often found in this functionless tooth. e.g., the base may be oval-shaped

(Leiden Museum, Reg. No. 3319), and the difference between length and width may be less than in the fossil specimen. The latter is larger, as a whole, than its recent homologues examined by me, but it is smaller than the P² from Java which von Koenigswald (1933, p. 9) refers to *Feliopsis palaeojavanica* Stremme, a species which has been placed by Brongersma (1935, p. 59) in the synonymy of *Panthera tigris* (Linnaeus).

P³ presents a fair amount of variation in the development of the metacone, which is incipient in the complete Wanh sien skull and distinctly developed in A.M.N.H. No. 18741. This is, however, of no importance, because I have found similar variations in the recent teeth. The upper carnassial is noticeable for the same variability in size of the paracone. P⁴ is also preserved in the partial skull (A.M.N.H. No. 18737), and in this specimen the paracone is of intermediate development. None of the teeth has a definite parastyle. The tiny M¹ is lost or too much damaged for study in our specimens.

Of the lower premolars, P₃ is proportionally longer in A.M.N.H. No. 18741 than in No. 18740, and the same holds for P₄. M₁, however, is shorter in the former than in the latter specimen. It is especially large in a young jaw (the fourth specimen under A.M.N.H. No. 18738). Study of variation in recent lower teeth of *Panthera tigris* (Linnaeus) convinces me that these variations are now exceptional. The only further point worthy of mention with respect to the teeth is their size.

Of the milk dentition there are two specimens, both with dc, dm₃, and dm₄, and a dm³. The latter tooth (first and second specimens under A.M.N.H. No. 18738) has a strong inner root, parastyle and paracone of equal development, pointed metacone, and elongated metastyle. The inner surface of the crown is convex anteroposteriorly, the outer approximately straight with a slight bulging below the metacone. The upper dc's have an antero-internal longitudinal ridge, which is not shown to such an extent in the permanent canines. The lower milk molars are built on the same general plan as the dm³ but reversed:

the outer surface convex and the paraconid elongated. Behind the main cusp or protoconid there are two cusps, of which the metaconid is stronger than the talonid. These milk teeth are identical in shape with those in living specimens. I have two young skulls for comparison, of which one (Leiden Museum, Reg. No. 1034), a female, is of unknown origin, and the other (Leiden Museum, Reg. No. 1120) is a hybrid between male *Panthera tigris sondaica* (Temminck) and female *Panthera tigris sumatrae* Pocock. Measurements are given in table 1.

the difference is so great as to induce one to distinguish different species. The latter example brings us to another point, viz., the alleged insular nanism.

The belief is widespread that the small size of so many insular species or races has something to do with restricted habitat, inbreeding, scarcity of food, etc. This explanation has been offered, e.g., for the existence of dwarf elephants and hippopotamuses on the Mediterranean islands, the Shetland pony, the Balinese tiger, Kuhl's deer of Bawean, the buffalo of Mindoro, the Sika deer of Japan. In opposition to this

TABLE 1
MEASUREMENTS IN MILLIMETERS OF MILK TEETH OF RECENT AND FOSSIL TIGERS

	<i>Panthera tigris</i> (Linnaeus)				
	Leiden Museum No. 1034	Leiden Museum No. 1120	A.M.N.H. No. 18738		
Upper dc					
Length	9.7	11.1	11.3	12.3	—
Width	6.0	6.2	7.6	7.1	—
dm ³					
Length	22.4	21.3	24.6	—	—
Width	6.7	6.1	7.4	—	—
dm ₂					
Length	12.2	12.2	—	14.0	14.3
Width	6.6	5.2	—	6.5	6.7
dm ₄					
Length	16.7	16.5	—	19.3	20.4
Width	6.7	5.8	—	7.0	7.5

It is not surprising that the Pleistocene teeth are larger than the recent. During my studies on recent and fossil mammals I have repeatedly found fossil and subfossil teeth and bones referable to living species to be slightly larger than the corresponding recent material. To quote a few examples from published papers, I may mention that the Pleistocene European hippopotamus, deer, bovids, and various Carnivora (Reynolds, 1902-1939, and others), the North American pumas and jaguars (Simpson, 1941), the Asiatic Przewalski's horse (Zdansky, 1935), chigetai (Boule and Teilhard, 1928), orang utan (Pei, 1935), and prehistoric tapir (Teilhard and Young, 1936) often have greater dimensions than their recent representatives. Sometimes, e.g., in the case of the urus, and in that of *Bubalus palaeokerabau* Dubois from Java,

view stands the evidence of the existence of, e.g., the giant asses of Malta and Cyprus, and the tall Polynesians in contrast to the Pygmies of the Congo forests, southern India, and New Guinea, the largest but one of the islands of the world. Among other vertebrates one might recall the Galápagos turtles, the "elephant birds" of Madagascar, and the giant moas of New Zealand. Moreover, small races of species may also be found on continents: e.g., races of the African elephant and of the mammoth.

The preceding digression is introductory to discussion of the dimensions of the permanent teeth, given in tables 2 and 3.

The 10 columns of table 3 give the observed range of variation of the measurements of:

1. *Panthera tigris sondaica* (Temminck),

Leiden Museum, Cat. a, d, h, j, Coll. Van Lidth de Jeude Nos. 314 and 319, Reg. Nos. 1929 and 4695.

2. *Panthera tigris sumatrae* Pocock, Leiden Museum, Cat. a, g, i, Reg. Nos. 315 (two skulls), 872, 2171, 2202, 3319, 4694, 4696-4698.

3. *Panthera tigris* (Linnaeus) subsp. from Java, as given by Stremme (1911), von Koenigswald (1933), and Brongersma (1935) from various Pleistocene localities.

4. *Panthera tigris* (Linnaeus) subsp. from prehistoric caves in the Padang highlands, Sumatra; teeth that were cursorily referred to by Brongersma (1937, p. 1862).

5. *Panthera tigris tigris* (Linnaeus) from India, as given by Hilzheimer (1905).

6. *Panthera tigris amoyensis* (Hilzheimer, 1905), based on five skulls secured

Tien, and Javan fossil tigers are larger than the recent tigers from the Greater Sunda Islands. The Indian tiger has the biggest jaws, but its teeth do not seem to be especially large; Pocock (1929, p. 517), however, gives 38 and 29 mm. for the maximum lengths of the upper and the lower carnassial, respectively. These figures are found only in fossil or subfossil but not in recent teeth from Java and Sumatra. The Manchurian tiger, as judged by Busk's (1874) figures (P^4 length, 36.8 mm.; M_1 length, 26.7 mm.) is only slightly inferior in size to the Indian form. The southern tiger from China is smaller than the Indian, but not so small as the insular subspecies. The Bali tiger is known to be the smallest of all races.

It is evident that the tiger has undergone

TABLE 2
MEASUREMENTS IN MILLIMETERS OF TEETH OF *Panthera tigris*
(LINNAEUS) SUBSPECIES, FOSSILS FROM WANHSIEN

A.M.N.H. Nos.	P^3		P^4		P_2		P_4		M_1	
	Length	Width	Length	Width	Length	Width	Length	Width	Length	Width
18624	19.3	10.5	33.3	—	14.9	—	22.8	—	—	—
18737	—	—	36.8	—	—	—	—	—	—	—
18741	24.5	13.0	38.1	19.9	18.0	10.0	25.7	13.0	27.6	14.7
18740	—	—	—	—	16.7	10.0	24.5	12.9	28.0	14.3
18738.4	—	—	—	—	—	—	—	—	31.2	15.4
18738.5	—	—	—	—	—	—	—	—	28.0	13.7

at Hankow, and originating from southern China.

7. *Panthera tigris* (Linnaeus) subsp. from the Pleistocene of Wanhsien, Szechwan, China, as described by Young (1932, upper C; 1939, M_1), Pei (1934, P_4 , M_1), and by the present author.

8. *Panthera tigris* (Linnaeus) subsp. from the Pleistocene of Chou Kou Tien, the *Sinanthropus* locality, as described by Zdansky (1928) and Pei (1934, 1936).

9. *Panthera tigris* (Linnaeus) subsp. from the archaeological site of Anyang, Honan, China, as described by Pei (1934) and Teilhard de Chardin and Young (1936).

10. *Panthera tigris altaica* (Temminck), from the Leiden Museum specimen (Cat. n).

From this table is seen that, although the different ranges of variation overlap to some extent, the Wanhsien, Chou Kou

a diminution in size in the course of time. The fossils prove this beyond doubt. Once there were living tigers in China and the Malay Archipelago which were as large as, if not even larger than, the largest of all surviving races. No doubt the species is now on its way to extinction; six of the nine subspecies were placed among the "Extinct and vanishing mammals of the Old World" by Harper (1945). I shall return to the size problem at the end of this paper.

The limb and foot bones in the Wanhsien collection have been compared with those of the living tiger and lion, of which I examined the following skeletons:

Panthera leo (Linnaeus)

1. Leiden Museum, Cat. d. Female, locality unknown. From the Rotterdam Zoo, April 1865.

2. Leiden Museum, Cat. e. Male, incomplete

TABLE 3
OBSERVED RANGES OF VARIATION OF MEASUREMENTS OF DENTITIONS OF RECENT AND FOSSIL TIGERS
(Specifications of the 10 samples are given in the text.)

	1. Java, Recent	2. Sumatra, Recent	3. Java, Fossil	4. Sumatra, Subfossil	5. India, Recent	6. Southern China, Recent	7. Wanh sien, Fossil	8. Chou Kou Tien, Fossil	9. Anyang, Subfossil	10. Vladivostok, Recent
Length of upper jaw	110-131	110-136	121.3	—	140-151	122-143	130-146	—	—	180
Upper C, length	20.5-25.0	20.0-28.0	25.1-31.6	—	—	—	23.5-31.0	27.0	—	25.4
Upper C, width	15.0-18.2	15.0-19.7	23.2	—	—	—	22-23.5	19.0	—	18.4
P ₃ , length	7.6-7.7	7.2-9.4	6.3-10	—	—	—	9.2	—	—	—
P ₃ , width	5.7-6.2	4.9-6.6	6.0-7	—	—	—	6.4	—	—	—
P ₃ , length	18.8-22.5	19.1-22.5	19.7-25.3	—	21.8-22.8	20-23.8	19.3-24.5	22.3-24.0	22.0	22.0
P ₃ , width	9.8-11.0	9.6-12.4	8.6-13.4	—	11.5-12.5	10.5-12.5	10.5-13.0	13.1-13.8	11.4	11.6
P ₄ , length	30.0-33.7	30.3-34.6	29.1-38.8	—	35-36.3	31-36	33.3-38.1	33.0-35.0	33.5	30.5
P ₄ , width	15.4-17.7	15.0-18.0	16.6-20.1	21.2-37.6	17-19	15-18	19.2-19.9	17.2-18.8	17.2	15.4
M ₁ , length	5.7-6.0	5.8-6.8	5.4	20.0-20.1	—	—	7.5	7.6	4.6	—
M ₁ , width	9.8-11.0	10.0-12.0	8.2	—	—	—	11.7	10.1	7.4	—
Length of lower jaw	173-210	175-219	195-222	—	203-225	184-219	ca. 215	—	194	218
Lower C, length	18.2-23.0	18.8-25.0	23.4-26	—	—	—	—	24.4	—	25.0
Lower C, width	13.1-15.8	13.0-17.0	—	—	—	—	—	17.3	—	15.7
P ₃ , length	13.5-16.3	13.1-16.0	15-19	15.7	16-17	15-17.3	14.9-18.0	15.5-20.3	15.6	15.9
P ₃ , width	7.0-8.0	7.0-8.0	7.3-10	8.2	7.8-8	8-9	10.0	8.2-9.7	8.0	8.9
P ₄ , length	19.7-22.9	20.4-23.5	22.0-28.5	22.0	23-24	21-24.3	22.2-25.5	22.2-25.5	22.4	22.8
P ₄ , width	10.0-10.5	9.1-11.8	10.8-14	11.6	11.8-12	10.5-12.5	12.9-13.0	13.0-14.2	11.2	10.0
M ₁ , length	22.1-25.3	22.2-26.0	23.8-30	26.3	26-27.8	23-26.5	25-31.2	24.0-28.4	25.5-26	24.5
M ₁ , width	11.8-13.0	12.0-13.7	12.1-16	13.5	13-14	11-14	13-15.4	13.4-15.6	13.4-13.5	12.2

skeleton of an individual that lived in the Tower in London, and originated in Africa.

3. Leiden Museum, Cat. f. Female from Africa, don. Van Aken.

4. Leiden Museum, Reg. No. 1751. Female, originating from Rhodesia, Rotterdam Zoo, May 17, 1929.

5. Leiden Museum, Reg. No. 2352. Male, locality unknown, from the Rotterdam Zoo, July 30, 1935.

Panthera tigris sondaica (Temminck)

1. Leiden Museum, Cat. a. Sex not recorded. Java, leg. Kuhl and Van Hasselt.

2. Leiden Museum, Reg. No. 1929. Male, Java, from the Rotterdam Zoo, February 13, 1931.

Panthera tigris sumatrae Pocock

3. Leiden Museum, Reg. No. 925. Male, Soengei Bras, Deli, Sumatra, from the Rotterdam Zoo, July 14, 1919.

4. Leiden Museum, Reg. No. 2171. Female, Sumatra, from the Rotterdam Zoo, June 6, 1933.

5. Leiden Museum, Reg. No. 2174. Male, Deli, Sumatra, from the Rotterdam Zoo, June 14, 1933.

6. Leiden Museum, Reg. No. 2202. Female, Palembang, S. Sumatra, 14 years old. From the Rotterdam Zoo, November 17, 1933.

Panthera tigris (Linnaeus) subsp.

7. Leiden Museum, Reg. No. 3075. Female, locality unknown, from the Rotterdam Zoo, May 20, 1937.

8. Leiden Museum, catalogued as *Felis leo* Linnaeus, Cat. a, by Jentink, 1887, p. 81. There is no record for the exact locality.

Panthera tigris altaica (Temminck)

9. Leiden Museum, Cat. n. Male, Vladivostok, Siberia, from the Rotterdam Zoo, November, 1897.

The observed ranges are given in tables 4-8. To avoid endless repetition, it can be said first that the fossil bones from Wanhhsien are all larger than those of the recent tiger of Java and Sumatra. The Vladivostok tiger is very near the fossils in dimensions, but the metapodials from Wanhhsien are very much more massive. There is one lion skeleton (No. 5) which presents slightly greater dimensions than the Wanhhsien tiger; the other lion skeletons are smaller. It is almost impossible to distinguish between the post-cranial skeleton of lion and tiger, but some points of difference will be noticed below.

The humerus in the Wanhhsien collection (A.M.N.H. No. 18448) is complete except for the lateral tuberosity. It is from the right side. I do not consider as of specific value the difference in shape of the lateral tuberosity in the humerus of a tiger and in

TABLE 4
MEASUREMENTS IN MILLIMETERS AND INDICES OF HUMERI OF FOSSIL
AND RECENT TIGERS AND OF RECENT LIONS

	<i>Panthera tigris</i> (Linnaeus) Fossil Wanhhsien	<i>P. leo</i> (Linnaeus) Recent	<i>P. tigris</i> (Linnaeus) Recent			
			Java	Sumatra	Loc.?	Vladivostok
1. Length from caput to middle of trochlea	306	253-329	256-284	257-279	295-296	310
2. Width across caput and posterior part of lateral tuberosity	67	59- 77	56- 62	53- 61	61- 62	68
3. Smallest width of shaft	28	24- 31	25	24- 25	23- 24	25
4. Greatest width of distal epiphysis	82	74- 91	68- 75	67- 77	72- 76	85
5. Width of trochlea	56	48- 61	46- 51	46- 51	50- 53	57
6. Anteroposterior diameter condylus medialis	56	48- 65	47- 51	46- 51	49- 52	57
7. Anteroposterior diameter condylus lateralis	46	39- 53	41- 42	39- 42	42- 44	46
8. Length-width index (meas. 2 $\times$ 100)/(meas. 1)	22	21- 27	22	21- 22	21	22
9. Trochlea-epicondyle index (meas. 5 $\times$ 100)/(meas. 4)	68	64- 69	68	66- 69	69- 70	67

that of a lion as indicated by Boule (1906, p. 74, figs. 9-10).

The measurements given by von Koenigswald (1933, p. 12) indicate the presence of still larger specimens in the Pleistocene of Java. One humerus is even stated to have a greatest length of 381 mm., others 353 mm., which is about the maximum I found in the lion (No. 5: 352 mm.) and that in a fossil humerus from Chou Kou Tien (Teilhard de Chardin, 1936, p. 15: 355 mm.). In *P. tigris altaica* (Temminck) the maximum length is 328 mm., and in the other recent tiger humeri it is 311 mm. at

flexor muscle of the digit is attached (two points of difference noticed by Brongersma, 1935, p. 61, in his description of the fossil tiger tibia from Java) is there a difference from the recent bones. In the length-width index and in the proximal epiphysis index the fossil specimens are seen to be entirely tiger-like.

The astragalus (A.M.N.H. No. 18691) is from the left side. Some substance is lost at the medial surface of the distal projection. Dawkins and Sanford (1866-1872, p. 13) give no differences between the astragalus of the lion and that of the tiger.

TABLE 5
MEASUREMENTS IN MILLIMETERS AND INDICES OF TIBIAE OF FOSSIL
AND RECENT TIGERS AND OF RECENT LIONS

	<i>Panthera tigris</i> (Linnaeus) Fossil		<i>P. leo</i> Lin- naeus) Recent	<i>P. tigris</i> (Linnaeus) Recent			
	Wan- hsien	Java		Java	Sumatra	Loc.?	Vladi- vostok
1. Length from intercondyloid eminence to median ridge of distal surface	297	282	257-309	247-273	249-275	291	314
2. Proximal width	78	68	71- 84	64- 70	63- 73	71- 72	76
3. Proximal anteroposterior diameter	81	70	75- 91	65- 72	62- 73	71- 75	78
4. Smallest width of shaft	25	25	25- 30	23- 25	23- 24	23- 24	27
5. Least anteroposterior diameter of shaft	24	22	21- 27	21	20- 23	20- 22	21
6. Length-width index (meas. 2×100) / (meas. 1)	26	24	25- 28	26	25- 27	24- 25	24
7. Proximal epiphysis (meas. 2×100) / (meas. 3)	96	97	88- 95	97- 98	99-107	96-100	97

the most. Teilhard de Chardin (1936, p. 15) remarks that in two specimens of the tiger collected in the late Pleistocene "Upper cave" of Chou Kou Tien the humerus does not even reach 300 mm. in length.

The tibia (A.M.N.H. No. 18448) is also from the right side. It lacks a portion of the lateral malleolus. The medial surface is injured distally. The nine tiger tibiae present great variations, and neither in the shape of the tuberosity for the patellar ligament, nor in the obliqueness of the ridges on the posterior surface between which the

My table shows, however, that the length-width index tends to be smaller in the tiger (89-98) than in the lion (95-102), and that the trochlea-caput index averages larger (tiger: 57-63, lion: 55-61). In the latter index the Wanhsien astragalus even surpasses the recent tiger, whereas the former index remains within the limits of the tiger. Tscherski (1892, p. 56, pl. 1, fig. 3) has described a left and a right astragalus from the Pleistocene of Lyakhov Island, off the north coast of Siberia. They are larger and smaller, respectively, than

TABLE 6

MEASUREMENTS IN MILLIMETERS AND INDICES OF ASTRAGALI OF FOSSIL AND RECENT TIGERS AND OF RECENT LIONS

	<i>Panthera tigris</i> (Linnaeus) Fossil		<i>P. leo</i> (Linnaeus)		<i>P. tigris</i> (Linnaeus) Recent		
	Wanh-sien	Lyakhov Isl.	Recent	Java	Su-matra	Loc.?	Vladivostok
1. Medial (greatest) length	61 64	58	45-60	46-50	46-55	50-52	56
2. Lateral length of trochlea	48 52	45	39-49	39-40	36-41	39-42	45
3. Greatest proximal width	57 —	—	44-57	43-49	44-49	47-50	54
4. Greatest distal width	37 41	34	27-33	27-29	25-30	29-30	31
5. Greatest width of collum	30 32	28	22-26	22	22-24	23-25	26
6. Length-width index (meas. 3 × 100)/(meas. 1)	93 —	—	95-102	93-98	89-96	94-96	96
7. Trochlea-caput index (meas. 4 × 100)/(meas. 3)	65 —	—	55-81	59-63	57-61	60-62	57

TABLE 7

MEASUREMENTS IN MILLIMETERS AND INDICES OF CALCANEA OF FOSSIL AND RECENT TIGERS AND OF RECENT LIONS

	<i>Panthera tigris</i> (Linnaeus) Fossil		<i>P. leo</i> (Linnaeus) Recent	<i>P. tigris</i> (Linnaeus) Recent			
	Wanh-sien			Java	Su-matra	Loc.?	Vladivostok
1. Greatest length	115 114		93-120	93-97	88-100	98-99	110
2. Length from outer part of tuber to base of inner astragaline articular surface (length of corpus)	85 85		67- 88	68-70	62- 74	70-72	82
3. Greatest width	45 45		34- 43	33-36	32- 36	35-37	39
4. Width at tuber calcanei	30 32		25- 34	25	22- 28	26-28	29
5. Greatest anteroposterior diameter	46 46		34- 48	36-38	35- 39	37-38	41
6. Anteroposterior diameter of inner astragaline articular surface	17 19		14- 18	14	12- 15	13	14
7. Transverse diameter of the same	21 21		16- 18	17-18	17- 19	17-18	19
8. Anteroposterior diameter of cuboidal articular surface	23 22		17- 23	17-18	16- 18	17-19	19
9. Transverse diameter of the same	27 27		22- 28	22	20- 23	21	25
10. Length-width index (meas. 3 × 100)/(meas. 1)	39 39		36- 38	35-37	36- 37	36-37	35
11. Corpus length index (meas. 2 × 100)/(meas. 1)	74 74		72- 75	72-73	70- 74	70-73	75
12. Tuber index (meas. 4 × 100)/(meas. 2)	35 38		35- 39	36-37	34- 38	36-40	35
13. Inner astragaline articular surface index (meas. 6 × 100)/(meas. 7)	81 90		88-100	78-82	71-83	72-74	74
14. Cuboidal articular surface (meas. 8 × 100)/(meas. 9)	85 82		75- 88	77-82	78- 85	81-90	76

our specimen from Wanh-sien. Tscherski refers his specimens to the recent tiger.

An astragalus from the Pleistocene of Chou Kou Tien (Pei, 1934, p. 133) seems to be rather small, length and maximum breadth being given as only 51 and 47 mm., respectively, unless the length is measured

at the lateral side of the bone and the breadth is taken across the calcaneum facets. If the measurements were taken in this way, they correspond in size with the other tiger bones from this locality, and are slightly larger than our specimen.

Two left calcanea are in the Wanh-sien

TABLE 8
MEASUREMENTS IN MILLIMETERS AND INDICES OF METAPODIALS OF FOSSIL
AND RECENT TIGERS AND RECENT LIONS¹

	<i>Panthera tigris</i> (Linnaeus) Pleistocene		<i>P. leo</i> (Linnaeus) Recent	<i>P. tigris</i> (Linnaeus) Recent				
	Wanhsien	Java		Java	Sumatra	Loc.?	Vladivostok	
Metacarpal II	(A.M.N.H. No. 18692)							
1	104	87+	86-100	81- 92	82- 89	92- 95	104	
2	26	21	19- 24	19- 21	17- 20	19- 20	22	
3	34	27	24- 29	23- 26	24- 27	23- 27	27	
4	17	15	11- 15	11- 12	11- 12	11- 12	12	
5	26	22	18- 24	17- 20	18- 20	19	20	
6	25	24	21- 24	23	20- 24	20- 21	21	
7	33	31	27- 29	28	29- 30	25- 28	26	
Metacarpal V	(A.M.N.H. No. 18693)							
1	87		80- 94	73- 78	70- 79	80- 82	90	
2	26		21- 26	18- 19	16- 20	19- 20	23	
3	26		20- 26	20	19- 22	21- 22	24	
4	16		11- 15	11- 12	10- 13	10- 11	12	
5	22		16- 23	17- 18	17- 19	17- 18	19	
6	30		26- 28	24- 25	23- 26	24	26	
7	30		25- 28	26- 27	25- 28	27	27	
Metatarsal II	Wanhsien	Lyakhov Isl.						
		(Tscherski)						
		113	98-121	95-103	93- 99	106-107	116	
	1	21.5	15- 18	14- 16	13- 17	15- 16	17	
	2	31	24- 29	24- 26	23- 26	25- 26	26	
	3	15.5	13- 15	12- 13	11- 12	10- 12	12	
	4	21	17- 24	18- 19	17- 19	18- 19	20	
	5	19	14- 16	15- 16	14- 17	14- 15	15	
6		28	22- 24	25	25- 26	23- 25	22	
7								
Metatarsal III	(A.M.N.H. No. 18698)	(A.M.N.H. No. 18694)	Java					
1	132	119	119	107- 36	108-116	107-114	118-119	130
2	28	25	23	23- 26	21- 23	21- 22	21- 22	25
3	37	35	33	29- 37	28- 30	27- 31	29- 30	31
4	19	17	16	13- 17	14	13- 15	12- 14	14
5	27	—	23	19- 26	20- 22	19- 22	20- 22	24
6	21	21	19	19- 21	19- 20	19- 20	18- 19	19
7	28	29	28	24- 29	26	24- 27	24- 25	24
Metatarsal IV	(A.M.N.H. No. 18696)	(A.M.N.H. No. 18695)	Java					
1	130	128	—	110-136	108-115	108-115	119	130
2	28	28	24	22- 27	21- 22	19- 23	22- 23	22
3	34	33	30	26- 34	26- 27	23- 27	26- 28	28
4	18	17	15	12- 15	12	12- 13	10- 11	12
5	25	24	—	17- 24	18- 19	18- 20	18	21
6	22	22	—	18- 21	19	17- 20	18- 19	16
7	26	26	—	22- 25	23- 25	20- 24	22- 24	22
Metatarsal V	(A.M.N.H. No. 18697)							
1	112			102-125	97-104	95-102	105-106	116
2	27			17- 28	18- 21	18- 21	19- 20	23
4	14			10- 14	10- 11	10- 12	9- 10	11
5	21			15- 18	16- 17	15- 18	16	18
6	24			16- 22	19- 20	18- 21	18- 19	20

¹ In this table the measurements are indicated by numbers: 1, median length; 2, proximal width; 3, proximal anteroposterior diameter; 4, smallest width of shaft; 5, distal width; 6, length-width index (meas. 2×100)/(meas. 1); 7, length-proximal anteroposterior diameter index (meas. 3×100)/(meas. 1).

collection (A.M.N.H. Nos. 18689, 18690). There is some variation in the shape of the inner articular surface for the astragalus. I have computed the articular surface indices indicated by Dawkins and Sanford (1866-1872, p. 14) as a character for discrimination between lion and tiger. Of the measurements and indices given in table 7, only few afford distinctive characters. The Wanhsien calcanea are identical in shape with those of the lion and tiger, with the exception that the length-width index (39) is somewhat greater than that in the lion (36-38) or tiger (35-37). There seems to be a small difference in the inner articular surface for the astragalus, the index being 71-83 in the tiger against 88-100 in the lion, but 1 mm. more or less means a difference of 4 to 6 units of the index, and it is seen that, while the first Wanhsien calcaneum is fully consistent with the tiger in this respect, the figure for the index in the second specimen falls within the limits of the lion.

The Chou Kou Tien calcaneum recorded by Pei (1934, p. 133) has a length of 86 mm., which must be the length of the corpus. The maximum breadth (45 mm.) is the same as that in our calcanea from Wanhsien.

The metapodials from Wanhsien (two metacarpals and five metatarsals) are all thicker than in either recent tiger or lion. They are of about the same length as, but much larger transversely and anteroposteriorly than, those of *P. tigris altaica* (Temminck), the Vladivostok specimen in the last column of table 8.

Another fact visible in table 8 is that the metapodials of the tiger are distinguishable from those of the lion by their somewhat more slender shape; consequently the Wanhsien tiger is closer to the lion than to the tiger in this respect.

It is remarkable that the metapodials from the Pleistocene of Java are more slender than those from Wanhsien and thus show a closer approach to the recent form than those of the Wanhsien Pleistocene. The length, however, is the same, at least in the case of the third metatarsal. It can be seen that the Javan fossils fall within the limits of the lion.

The second metacarpal from Java in the Dubois collection is remarkably short, its median length being only 87 mm. as opposed to 81-104 in the recent tiger.¹ This bone, however, consists of two portions (Brongersma, 1935, pl. 9, fig. 2), and the examination of the original specimen convinced me that the fragments do not match precisely and that a small part of the shaft must be lost. The Javan fossil is much smaller transversely and anteroposteriorly than the corresponding bone from Wanhsien, but its shaft is thicker (15 mm.) than in the recent tiger (11-12 mm.). The same thickness of shaft as in the fossil was found as the maximum in the lion.

Of the two third metatarsals from Wanhsien the first is almost equal in length to, but thicker than, that of the Vladivostok tiger, and the other is equal in length to, but thicker than, the third metatarsal from the Pleistocene of Java in the Dubois collection (Brongersma, 1935, pl. 9, fig. 3).

The fourth metatarsal from the Pleistocene of Java (Brongersma, 1935, pl. 9, fig. 1) lacks the distal extremity, and consequently, the length cannot be given. Its proximal part and shaft are again seen to be more slender than in the corresponding bone from Wanhsien. It is, however, thicker again than the recent fourth metatarsal from Vladivostok, as are the other fossil metapodials from Java.

There is another fossil tiger which presents as massive a metapodial as that from Wanhsien. The fossil second metatarsal from Lyakhov Island, off the north coast of Siberia, described and figured by Tscherski (1892, pp. 58-60, pl. 1, fig. 4), is equal in length to the corresponding bone of the Vladivostok tiger, but is greater in the other dimensions, to just the same extent as the Wanhsien bones. It is the only metatarsal which is not represented in the

¹ Von Koenigswald (1933, p. 12) ascribes a second and a fourth metacarpal to the fossil tiger from Java as having lengths of 70.5 and 68 mm., respectively. This is much too short, even for a recent tiger, and I believe the bones to belong to the panther which is also known from the Pleistocene of Java (Brongersma, 1935, p. 71). In two recent skeletons of *Panthera pardus* (Linnaeus) from Java (Leiden Museum, Cat. a and b) the length of the second metacarpal is 54-56 mm., and that of the fourth 61-63 mm. This accords well in size with the humerus from the Javan Pleistocene which von Koenigswald (1933, p. 18) tentatively refers to the panther, which is also longer (228 mm.) than the recent (194-205 mm.).

Wanh sien collection, but, in fact, it might have come from that locality. It has exactly the same disproportional dimensions as compared to the living species and does not fall within the limits of the lion, as the fossil metapodials from Java do. Tscherski (1892, p. 61) does not hesitate to refer the other bones examined by him (a femur from the Jana River system in Siberia, the astragali mentioned above and a phalanx from Lyakhov Island) to *Panthera tigris* (Linnaeus), but is reticent as to the metapodial. Now that we have discovered in Wanh sien a fossil tiger that also presents the greatest deviation from the recent form in its metapodials (no doubt a constant character, as represented in seven bones from different individuals), all doubt is removed about the question as to whether the massive metatarsal belongs to the Siberian tiger or not. And the remarkable fact is disclosed by the direct comparison of the Chinese fossils with those of Java that the Pleistocene Javan tiger had less thick metapodials than the Chinese and Siberian, and thus is nearer to the recent form.

I should not have hesitated to propose a new subspecific name for the Wanh sien tiger were it not that I have found that the Pleistocene Siberian tiger described by Tscherski has exactly the same distinguishing feature. The Pleistocene southern Chinese tiger and the Siberian form are so widely separated in locality that in the recent fauna they certainly would have been shown to represent different geographical races. The Chou Kou Tien tiger is intermediate in locality, and consequently it is highly probable that when some day its metapodials come to light, they will be seen to have also the massive shape which seems typical for the large Pleistocene continental forms. According to the International Rules of Zoological Nomenclature the Pleistocene Chou Kou Tien tiger then has to bear the name *Panthera tigris acutidens* (Zdansky), and the same name would apply to the Wanh sien and the Siberian form. Therefore, pending the question of its racial identity with the Chou Kou Tien tiger, I leave the Wanh sien tiger subspecifically unnamed.

Taking into consideration all the facts

concerning fossils gathered above, we can make the following statements:

1. The Pleistocene tiger of Wanh sien, like that of Chou Kou Tien, Java, and Siberia, was as large as the largest of the living subspecies of *Panthera tigris* (Linnaeus).

2. The Siberian form has decreased little, if any, in size since the Pleistocene, but its metapodials have become much more slender.

3. The Chinese form has become smaller than the northern and Indian forms, but not so small as:

4. The Javan form, in which the metapodials were already more slender than those of the continental forms in the Pleistocene, and which must have passed since then through the stages of size today represented by the typical (India), the northern (Manchuria, Siberia), the Chinese, and the Sumatran races, respectively.

The chain of evidence is still far from complete; we badly need fossil tigers from India, Sumatra, and Bali as evidence of what we can now only infer. Is it more than a curious coincidence that the tigers on the smaller islands have become smaller in size than on the larger islands, or is the apparent coincidence related to the fact that the smaller the island, the more peripheral its location in southeastern Asia? I am inclined to the latter view, but I must admit that I do not know what mechanism is responsible for the gradual alteration in size within the species *Panthera tigris* (Linnaeus) from the continent to Bali, as observed at the present day.

Similar clines (Huxley, 1939) have been observed in other southeastern Asiatic mammals. Each of the links has been named as a subspecies, and the fossils throw some light on the early history of the now isolated forms. We now know at least two subspecies of tiger living in the Pleistocene, viz., the large and broad-footed Chinese and Siberian form (for the present inseparable, but probably deserving of distinct subspecific names) and the likewise large, but comparatively slender-footed Javan form which might be called *Panthera tigris groeneweldtii* (Dubois) (see Brongersma, 1935, p. 61). There must have been

other races already in existence at that time, and each of them must have come down to the present by gradually changing its characters into those of the subspecies we distinguish today.

In my paper on the fossil and prehistoric rhinoceroses from the Malay Archipelago (Hooijer, 1946) I did not distinguish subspecies, but it is highly probable that, e.g., the prehistoric *Dicerorhinus sumatrensis* (Fischer) from Sumatra is the same as *D. sumatrensis lasiotis* (Sclater) (see Hooijer, 1946, p. 29), and that the Pleistocene *Rhinoceros kendengindicus* Dubois from Java is a subspecies of the recent Indian *R. unicornis* Linnaeus which also dates back to the Pleistocene (Narbada beds). The view is held by Weidenreich (1943, p. 246) that *Pithecanthropus erectus* Dubois and *Sinanthropus pekinensis* Davidson Black are races of one and the same species; the correct names then would be trinomial: *Pithecanthropus erectus erectus* Dubois and *Pithecanthropus erectus pekinensis* (Davidson Black).

I have evidence in other mammals that are represented by the same species in the

Pleistocene and (if not extinct) the recent fauna of Java and also in the Pleistocene and/or the recent fauna on the Asiatic continent, that the process of raiation had already begun in the Pleistocene, and that consequently the recent races are the descendants of the racially distinct populations that already existed in the Pleistocene. It is significant that the skull of the Pleistocene tiger of Java already had the narrow occiput that is characteristic of the recent subspecies of that island (Brongersma, 1935, p. 59).

As the external characters which are of paramount importance for the distinction of present day's subspecies leave no record in the skeleton, they probably are lost forever. We can only postulate that the Pleistocene Javan tiger did not have a winter coat. If *Pithecanthropus* and *Sinanthropus* had been trained as systematic zoologists, they doubtless would have found many more characters to distinguish between the northern and the southern forms of the tiger which in their time were of equal size and which we can now distinguish only by the structure of their feet.

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Fig. 1. *Panthera tigris* (Linnaeus) subspecies A M N H No 18024, skull with lower jaw in situ. Right lateral view, somewhat ventral because of strong oblique crushing. One-half natural size.



Fig 2. *Panthera tigris* (Linnaeus) subspecies. A.M.N.H. No. 18737, anterior part of skull with lower jaw *in situ*. Anterior view. One-half natural size.



Fig 3 *Panthera tigris* (Linnaeus) subspecies. A, A.M.N.H. No. 18698, right third metatarsal
B A.M.N.H. No 18692, left second metacarpal Both anterior (dorsal) views Natural size.

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A FISSICORN SYRPHID FLY FROM BRAZIL (DIPTERA)

By C. H. CURRAN

Two microdontine flies were contained in a small collection of flies collected in southern Brazil by Mr. A. Maller, and donated to the Museum by Mr. Frank Johnson. One of these belongs to the recently described genus *Aristosyrphus* Curran, and is apparently *primus* Curran, though differing slightly from the type. The second specimen possesses a most unusual type of antennal formation for the Syrphidae, since the third antennal segment is furcate on almost its whole length. This character is found in some genera of Tachinidae, but in this family there is usually a difference in the shape of the male and female antennae. Some of the Tabanidae have the antennae forked with the upper branch sometimes almost as long as the lower, but the lower branch is annulate.

Because of the normal shape of their antennae, *Microdon* and allies are the only group of Syrphidae in which one might expect to find furcate antennae, and it is no great surprise to discover this condition. Fortunately, the single known specimen is a female, proving that the character is common to the two sexes, and I am therefore placing the fly in a new genus. Had it been a male, there would have been doubt about the female antennae being of similar structure since in other groups of the genus there are often slight differences in the two sexes.

JOHNSONIODON, NEW GENUS

This genus belongs to the Microdontinae and has a strong superficial resemblance to the *globosa* group; the general structure of the head is also typical of this group. It is separated from all known members of the subfamily in having the third antennal segment divided into two long branches, the lower one being conspicuously thicker and very slightly longer; both lobes bear long

pubescence, that on the upper lobe being longer than most of that on the lower. The scutellum is very shallowly emarginate apically, and without spines. Legs with short, appressed hair, the hind tibiae without the usual impressed incomplete ring above. There is no stump of vein extending from the third vein into the apical cell, which is shorter in the middle due to the inward angulation of the apical cross vein, a stump of vein extending into the cell from the angulation. The abdomen is almost twice as long as wide. Genotype, the following species.

Johnsoniodon malleri, new species

Brownish, with luteous and yellow markings on the thorax, the legs light orange, the abdomen with indications of blue black. Length, 9 mm.

FEMALE: Face wider than either eye, widest above, very slightly narrowing below; front narrowing to the upper third, thence slightly widening to the vertex. Front black laterally, brown in the middle and on the upper third, the ocellar tubercle black; pile dull brassy, appressed except above. There is no distinct transverse frontal depression, but there are oblique, irregular ridges on each side, these being especially noticeable just above the middle. Ocellar triangle small, slightly longer than wide, lying slightly in front of the anterior angle of the eyes. Occiput not swollen, cinereous yellow pollinose, the pile short brassy yellow. Cheeks scarcely projecting below the eyes. Face brown, with large, oblique lateral depressions black, and a black lateral triangle projecting downward from the front along the orbits. In profile, the face is very slightly retreating, with a gentle convexity on the upper third, the lower part strongly convex; in general, the face follows the contour of the eyes and

projects only a little beyond them; pile mostly limited to the depressions, golden yellow. Antennae black, the third segment brown, considerably longer than the basal two, the second segment broader than long. The third segment is divided into two well-separated, parallel lobes, the lower about three times as wide as the upper, but appearing only about twice as wide owing to the long pubescence on the latter; while

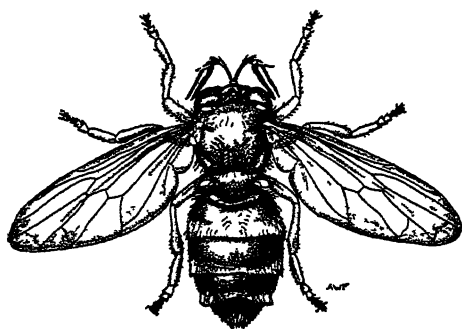


Fig. 1. *Johnsoniodon malleri*, new species.
Female. $\times 3$.

the lower lobe is conspicuously pubescent, the pubescence is long only on the inner side. Arista very short and thick, tapering apically, situated on the outer side in the concavity formed by the base of the fork. Eyes bare.

Thorax pale brown, the mesonotum with very broad, sublateral, paler vittae that taper behind and are rounded in front and

semi-interrupted at the suture; humeri pale luteous; mesosternum and a large spot above the hind coxae reddish yellow. Pile moderately long, subappressed, brassy yellow; black on the pleura and on the sides of the scutellum. Scutellum more than twice as wide as long, the apex gently emarginate.

Legs bright orange, the coxae and apical two segments of the tarsi brown; the basal third of the tibiae pale yellowish; pile golden yellow, appressed except on the hind femora, black on the posterior four coxae.

Wings brownish gray, the veins brown; both the apical and discal cells are longest posteriorly, the apical cross vein extending obliquely forward, then obliquely outward, the angle at the middle. Squamae brown, the lower lobe mostly dull yellowish, with orange border and fringe. Halteres reddish.

Abdomen dark brown, without magnification rather bluish black. Pile black, short, on the second segment a large patch of pale brassy pile on each side and scattered pale hairs on the disc, so that in some views the pile appears to be mostly brassy; third and fourth segments each with a broad, broadly interrupted apical band of pale pile, the fifth with the apex broadly pale pilose. The pile on the lateral margins is all black. Venter shining brown, with black hair.

HOLOTYPE: Female, Corupa (Hanse Humbolt), Santa Catharina, Brazil, November, 1945 (A. Maller).

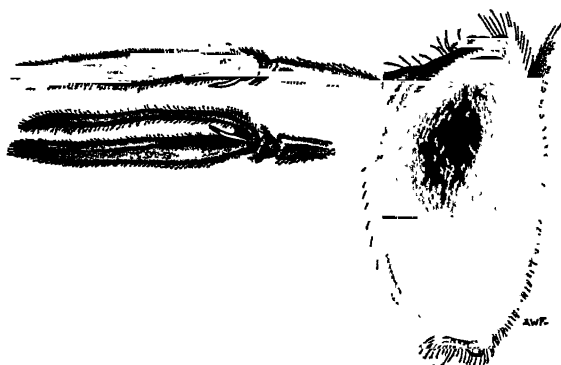


Fig. 2. *Johnsoniodon malleri*, new species.
Lateral view of head and antenna.

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EREBIA YOUNGI HOLLAND, ITS SUBSPECIES AND DISTRIBUTION (LEPIDOPTERA, SATYRIDAE)

BY CYRIL FRANKLIN DOS PASSOS

The studies reported in this paper are the result of correspondence with B. C. S. Warren in connection with his proposed supplement to a monograph of the genus *Erebia* published in 1936. It was found that one of Leussler's species is best regarded as a subspecies of *E. youngi* Holland (1900, p. 388) and that, in addition to these two previously named populations, there is a third recognizable subspecies in the Mount McKinley region of Alaska.

The type localities herein mentioned are situated in Alaska, and in the District of Mackenzie, Northwest Territories, Canada, and as the crow flies are about the following distances from each other:

McKinley Park to Forty Mile and Mission Creeks	255 miles
McKinley Park to Herschel Island	490 miles
Forty Mile and Mission Creeks to Herschel Island	365 miles

Aklavik, also mentioned in this paper, but not a type locality, is in the District of Mackenzie, Northwest Territories, Canada, about 140 miles southeast of Herschel Island, and about 305 miles from the mountains between Forty Mile and Mission Creeks. It appears, therefore, that the type localities of the three subspecies discussed herein are at the corners of a triangle, lying approximately between latitudes 63° and 70° N. and longitudes 141° and 150° W. The range of the species is doubtless much wider, but so little collecting has been done thus far in Alaska and Northwest Territories that specimens of *Erebia* from there are extremely rare in collections.

Erebia youngi youngi Holland

Erebia youngi HOLLAND, 1900, Ent. News, vol. 11, p. 388.

Erebia youngi, GIBSON, 1920, Report of the

Canadian Arctic expedition 1913-18, vol. 3, pt. 1, p. 181, pl. 4, fig. 10.

Erebia youngi HOLLAND, 1931, The butterfly book, revised ed., p. 205, pl. 61, fig. 28, ♂, type; fig. 29, ♀, type; fig. 30, "♀," under side, paratype.

Erebia youngi, WARREN, 1936, Monograph of the genus *Erebia*, p. 242, pl. 83, figs. 1166, 1172.

Erebia youngi, McDUNNOUGH, 1937, Canadian Ent., vol. 69, p. 18.

Erebia youngi, DOS PASSOS, 1939, Bull. Cheyenne Mt. Mus., vol. 1, pt. 2, p. 8-13.

This insect was described from a series of three males and one female taken by the Rev. S. Hall Young in the mountains between Forty Mile and Mission Creeks, northeast Alaska, latitude 64° N., on July 20, 1899. Holland's figure (*op. cit.*, fig. 30) of a "♀," paratype is, in fact, a male. Through the courtesy of Dr. W. R. Sweadner, Curator of Entomology, Carnegie Museum, it has been possible to make a slide of the genitalia of this cotype. At the same time Dr. Sweadner advised the author that the third male cotype was missing from the collection. This missing specimen was not figured by Holland, but, fortunately, photographs of the entire type series are in the present author's collection. Dr. Sweadner also wrote that the males expand 38.5-39 mm., not 33 mm., and the female expands 38.25 mm., not 35 mm., as stated in the original description.

The genitalia of a specimen of *youngi* from Nansen Creek, Yukon, Canada, is figured by Warren (*op. cit.*, pl. 42, fig. 385). An examination of that figure, the dissection of a cotype of *youngi youngi*, and of a specimen from Arctic Circle, Alaska, in this author's collection, show that this subspecies usually has the most complex form of clasp with three rows of spines, one on the costa of the clasp and one below the costa on either side.

HABITAT: The habitat of this sub-

species will probably be found to be in the basin of the Yukon River and its tributaries in northwest Alaska. There is a substantial mountain barrier between this territory and that of the following subspecies.

MATERIAL EXAMINED: Three male and one female cotypes, all then in the Carnegie Museum, and genitalia (slide no. 245, C. F. dos Passos) of the "♀," paratype figured by Holland (*op. cit.*) in the collection of the Carnegie Museum; one male, "Arctic Circle," Alaska, August (slide no. 256, C. F. dos Passos), in the collection of the author. This specimen was purchased from the late Herman J. Erb, and probably came from Circle, Alaska, which is about 50 miles south of the Arctic Circle, and about 150 miles from Mission Creeks, both localities being on the Yukon River. Most of Erb's Alaskan material came from Circle although sometimes labeled "Arctic Circle."

Erebia youngi herscheli Leussler

Erebia youngi, CARY, 1906, Proc. U. S. Natl. Mus., vol. 31, p. 448.

Erebia youngi, BRYANT, 1935, Bull. Brooklyn Ent. Soc., vol. 30, pp. 2, 8.

Erebia herscheli BRYANT (*nomen nudum*), 1935, Bull. Brooklyn Ent. Soc., vol. 30, p. 6.

Erebia youngi, LEUSSLER, 1935, Bull. Brooklyn Ent. Soc., vol. 30, pp. 51, 61.

Erebia herscheli LEUSSLER, 1935, Bull. Brooklyn Ent. Soc., vol. 30, pp. 51, 60.

Erebia herscheli, McDONNOUGH, 1937, Canadian Ent., vol. 69, p. 18.

Erebia herscheli, dos PASSOS, 1939, Bull. Cheyenne Mt. Mus., vol. 1, pt. 2, p. S-13.

This insect was described from a series of three males taken by Owen Bryant on Herschel Island, Yukon, Canada, latitude 70° N., on July 20, 1930. This island is in the Beaufort Sea, a short distance from the mainland. The holotype and one paratype were subsequently acquired from Bryant by the present author, and the holotype was presented to the American Museum of Natural History. The other paratype remained in the collection of the late R. A. Leussler, who worked up most of Bryant's Arctic butterflies. Recently Leussler's collection was acquired by the Ohio State University.

Dissections of the holotype of *herscheli*,

and of the paratype in this author's collection, show that *herscheli* is, in fact, a subspecies of *youngi*, the genitalia being substantially similar except that there are usually only two rows of spines instead of three as in *youngi youngi*, one on the costa of the clasp and one just below the costa on the outer side. The spines are most numerous on the clasp of *herscheli*, being closer together than on *youngi*.

When Leussler described *herscheli*, he had also before him a few specimens of both sexes of *Erebia* from Aklavik which he referred to *youngi*. This series, or part thereof consisting of four males and two females, is before me. They are similar in size and pattern to the type series of *herscheli* except that the males do not have clearly defined, pale submarginal bands on the under side of the secondaries. This may be owing in part to the fact that they are "all somewhat the worse for wear" as Leussler mentioned. Occasional specimens of *youngi youngi* also lack this submarginal band. The genitalia of two of these specimens from Aklavik agree well with the two dissections of *herscheli*. Leussler was undoubtedly in error in referring these six specimens to *youngi*. Leussler (*tom. cit.*) terms *herscheli* "... a very obscure little insect." He further states "... it is a decidedly smaller ..." insect than *youngi*, while a few lines above he gives the expanse of *herscheli* as 40 mm., whereas Holland's published expanse of *youngi* is 33 mm. It is obvious that Leussler was not familiar with typical *youngi*, and that his statement concerning the respective sizes of the insects mentioned is contrary to the facts. The holotype of *herscheli* and the paratype in my collection expand, respectively, 39.5 mm., and 41.4 mm.

HABITAT: The habitat of this subspecies probably will be found to be in the basin of the Mackenzie River and its tributaries. The Richardson Mountains, Ogilvie Range, and Mackenzie Mountains would appear to present a substantial barrier between this subspecies and the former one.

MATERIAL EXAMINED: Holotype male, and one male paratype, both from Her-

schel Island, Yukon, Canada, latitude 70° N. (Beaufort Sea), July 20, 1930 (slides nos. 257 and 243, C. F. dos Passos). The holotype is in the American Museum of Natural History, and the paratype in this author's collection; two males, Aklavik, Northwest Territories, July 11, 1931 (O. Bryant), and two males, same locality and collector, July 24, 1931 (slides nos. 253 and 239, C. F. dos Passos); two females, same locality, dates, and collector, all in the collection of this author, *ex* collection Owen Bryant.

Erebia youngi rileyi, new subspecies

MALE: Expanse 30.9 – 39.6 mm.; holotype 37.6 mm.

ABOVE: Primaries and secondaries Brussels Brown,¹ Light Seal Brown (holotype), or Bone Brown, the primaries with a submarginal row of four Apricot Buff or Ochraceous-Orange ocelli, each with a Black pupil somewhat elongated. Occasional specimens have ocelli lacking one or more pupils, and some lack the apical ocelli. Secondaries sometimes with one to three small submarginal spots, Apricot Buff or Ochraceous-Orange, faintly pupilled with Black.

BELOW: Primaries, basal, and limbal areas Verona Brown, Warm Sepia, or Light Seal Brown, separated by an Apricot Buff or Ochraceous-Orange submarginal band, cut by the nervules, in which the ocelli reappear, or in a few instances appear as Black points. Secondaries, basal, and limbal areas separated by a crenulate median band, the same color as the primaries, between which and the marginal crenulate band there is a wide submarginal band. Avellaneous, Wood Brown, or Fawn color. Fringes concolorous with wings—somewhat paler.

Head concolorous with wings; antennae annulated, White and Light Seal Brown, with spoon-shaped, Apricot Buff and Black club; thorax and abdomen Black with hairs the color of the wings; legs paler than wings.

FEMALE: Expanse 34.5 – 41 mm.; allotype 34.5 mm.

ABOVE: Primaries and secondaries Brussels Brown (allotype) or Warm Sepia, the primaries with a submarginal row of four Apricot Buff or Ochraceous-Orange ocelli; six specimens with Black pupilled ocelli somewhat elongated; pupils obsolete in four specimens. Secondaries occasionally with one to three small submarginal spots, Apricot Buff or Ochraceous-Orange, faintly pupilled with Black.

BELOW: Primaries, basal, and limbal areas Verona Brown or Warm Sepia, separated by an Apricot Buff or Ochraceous-Orange submarginal band, cut by the nervules, in which the ocelli sometimes reappear, or in a few instances appear as Black points. Secondaries, basal, and limbal areas separated by a crenulate median band, sometimes only outlined, at other times solidly colored, between which and the marginal crenulate band there is a wide submarginal band, Light Drab, Light Olive-Gray, or Drab, sometimes indistinct. Fringes concolorous with wings.

Head concolorous with wings; antennae similar to males, but darker; thorax and abdomen Black with hairs the color of the wings; legs paler than wings.

Specimens, both male and female, that do not show any Black pupil in the ocelli on the primaries usually have faint Apricot Buff submarginal points between the veins on the under side of the secondaries.

This subspecies is named for my friend, N. D. Riley, Keeper, Department of Entomology, British Museum (Natural History).

Usually this new subspecies has the simplest form of clasp, and the fewest spines—only in one row on the costa of the clasp with a few sometimes on the outside (slides nos. 238 and 247, C. F. dos Passos). From the eight dissections of *youngi*, no positive conclusions can be drawn. There is considerable individual variation among specimens from the same locality, although the general form of the male genital armature is similar in all three subspecies. In separating the subspecies it must be conceded that in so far as the studies have progressed, the results, while useful, nec-

¹ All color terms are those employed in "Color standards and color nomenclature" by Robert Ridgway, Washington, D. C., 1912, published by the author.

essarily lack finality. Other superficial characters must be considered also.

In addition to the genitalic characters, *rileyi* may be distinguished from *youngi* *youngi*, its nearest relative, by the slightly smaller size, the narrower, more broken, and somewhat darker submarginal band on the upper and under sides of the primaries in both sexes, by the general absence of the submarginal markings on the upper side of the secondaries in both sexes (those on the cotype of *youngi* *youngi* being Black pupilled, a condition not observed in most of the females of *rileyi*), and by the fact that about one-quarter of the specimens in both sexes of *rileyi* do not show any Black pupil in the ocelli on the upper and/or under sides of the primaries. On the secondaries the basal area of *youngi* *youngi* is concolorous with the median band, whereas in *rileyi* it is usually the same color as the submarginal band. The new subspecies may be distinguished from *herscheli* by the smaller size. The median band on the under side of the secondaries of *herscheli*, when present, is almost concolorous with the rest of the wing, and the submarginal band is also less prominent and lacking in most specimens examined, while the reverse usually is true in *rileyi*.

HABITAT: The habitat of this subspecies is in the Alaskan range, where it seems to fly at about 3500 feet elevation. A large portion of this range is in the Mount McKinley National Park. No barrier appears to exist between *rileyi* and *youngi* *youngi*, unless the low lands along the Tanana River act as such. If not, it would seem that further collecting in this region will establish the intergradation of the two subspecies.

TYPE MATERIAL: The holotype male is from McKinley Park, Alaska, June 19, 1932, and the allotype female is from Mount McKinley Park, Alaska, June 20, 1932. There are 15 pairs of paratypes from Alaska as follows: six males and six females, McKinley, July 4-15, 1930, *ex* collection J. D. Gunder; three males, McKinley Park, June 20, 1932, and six females, same locality, between June 17 and June 28, 1932; five males, Mount McKinley Park, between June 25 and July 9, 1932, and one female, same locality, July 10, 1932; one female, McKinley National Park, July 11, 1931, *ex* collection J. A. Comstock; one male and one female, Mount McKinley Park, July 5, 1938, 3500 feet (G. P. Engelhardt). The holotype, allotype, *ex* collection of the author, and six pairs of paratypes, *ex* collection J. D. Gunder, are in the American Museum of Natural History. The remaining paratypes are in the collection of the author.

ADDITIONAL MATERIAL EXAMINED: The author has examined also the following specimens of *rileyi* from Alaska, but they are not made paratypes: one male, McKinley Park, July 29, 1930 (D. Fraser); 12 males and four females, McKinley, July 4-15, 1930, *ex* collection J. D. Gunder, all in the American Museum of Natural History; three males and two females, McKinley Park in the collection of B. C. S. Warren, Folkestone, Kent, England, *ex* collection C. F. dos Passos; four males, McKinley Park, in the collection of Don B. Stallings, Caldwell, Kansas, *ex* collection C. F. dos Passos; 47 males, labeled variously McKinley Park, Mount McKinley Park, 3500 feet, and McKinley National Park, between June 15 and July 22, in the collection of the author.

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NEW CERAMBYCID BEETLES BELONGING TO THE TRIBE RHINOTRAGINI FROM SOUTH AMERICA

By W. S. FISHER¹

This paper reports a study of some cerambycid beetles belonging to the tribe Rhinotragini received for identification from Lionel Lacey of New Rochelle, New York, and the American Museum of Natural History. Seven species are described as new.

Ommata (Chrysaethe) atrocephala, new species

FEMALE: Slender, rather strongly shining; head, elytra, upper margin of anterior tibiae, middle tibiae, posterior legs (except bases of femora), middle and posterior tarsi, and last abdominal sternite black or brownish black; pronotum, under side of body (except last abdominal sternite), anterior legs (except upper margins of tibiae), middle femora, and bases of posterior femora red or brownish yellow; antennae black, each with the five apical segments yellow at bases.

Head prolonged into a short, broad snout, coarsely, sparsely punctate, more densely punctate on occiput, with a narrow longitudinal groove extending from clypeus to occiput, sparsely clothed with short, erect, inconspicuous hairs; eyes large, deeply emarginate, separated on the front by about one-half the width of the clypeus. Antenna short, rather slender, slightly expanded towards apex but not serrate; basal segments rather densely ciliate on under side with short, semi-erect, brown hairs.

Pronotum subcylindrical, distinctly longer than wide, slightly narrower at apex than at base, widest at middle; sides vaguely rounded at middles; disk slightly uneven, strongly convex, broadly, trans-

versely flattened along base and anterior margin; surface coarsely, sparsely, irregularly ocellate-punctate, more densely punctate along base, sparsely, irregularly clothed with short, erect, inconspicuous hairs. Scutellum broadly, longitudinally grooved at middle, sparsely clothed with short, recumbent, whitish hairs.

Elytra at base slightly wider than pronotum, extending to apex of fourth abdominal sternite, abruptly narrowed behind basal fourth, not dehiscent along sutural margins; sides nearly parallel along apical halves, the tips separately, broadly, obliquely truncate; surface coarsely, densely, uniformly punctate, sparsely clothed with short, semi-erect, white hairs.

Abdomen beneath vaguely granulose, sparsely, rather coarsely punctate, sparsely clothed with short, semi-erect, yellowish hairs; last visible sternite broadly rounded at apex. Posternum coarsely, shallowly, irregularly punctate posteriorly, impunctate along anterior margin, sparsely clothed with short, semi-erect, inconspicuous hairs. Legs sparsely clothed with long, erect hairs. Anterior and middle legs short. Posterior legs long, slender. Femora strongly, abruptly clavate at apices. Posterior tibiae straight, cylindrical.

Length 9.5 mm., width 1.75 mm.

TYPE LOCALITY: Hansa Humboldt, Santa Catharina, Brazil.

TYPE: In the Lionel Lacey Collection, deposited in the American Museum of Natural History.

Described from a single female collected during November, 1940, by A. Maller.

This species is allied to *Ommata globulicollis* Melzer, but it differs from the description given for that species in having the elytra uniformly brownish black, and the pronotum, under side of the body, and

¹ Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture.

anterior and middle femora red or brownish yellow.

***Ommata (Rhopalessa) longipennis*,
new species**

MALE: Slender, strongly shining; head, pronotum, elytra, antennae (except bases of segments which are yellow), under side of body, upper margins of anterior and middle tibiae, tarsal claws, and posterior legs (except basal halves of femora) black or brownish black; palpi, anterior and middle legs (except tarsi and upper margins of tibiae), and bases of posterior femora yellow.

Head prolonged into a short, broad snout, densely, coarsely punctate on occiput, with a few coarse punctures between the eyes, and a narrow longitudinal groove extending from clypeus to occiput, clothed with a few long, erect, inconspicuous hairs; eyes large, deeply emarginate, nearly contiguous on the front. Antenna slender, gradually expanded towards apex but not serrate, extending to second abdominal sternite, basal segments sparsely ciliate on under side with short, semi-erect, brown hairs.

Pronotum subcylindrical, distinctly longer than wide, subequal in width at base and apex, widest at middle; sides vaguely rounded at middles; disk strongly convex, slightly, transversely flattened along base and anterior margin; surface coarsely, rather densely, irregularly punctate, more densely punctate along base, sparsely clothed with short, erect, inconspicuous hairs. Scutellum broadly, longitudinally concave, sparsely clothed with short, recumbent, white hairs.

Elytra at base slightly wider than pronotum, extending to apex of fourth abdominal sternite, abruptly narrowed behind basal fourth, not dehiscent along sutural margins; sides parallel along apical halves, the tips separately, broadly, obliquely truncate; surface coarsely, deeply, densely, uniformly punctate, sparsely clothed with short, erect, white hairs.

Abdomen beneath vaguely granulose, coarsely, sparsely punctate, sparsely clothed with long and short, erect, white hairs; last visible sternite broadly concave,

broadly truncate at apex. Prosternum finely, transversely rugose at middle, sparsely, finely punctate at sides, impunctate along anterior margin, sparsely, irregularly clothed with long, erect, inconspicuous hairs. Legs sparsely clothed with rather long, erect, white hairs. Anterior and middle legs short. Posterior legs long, slender. Femora strongly, abruptly clavate at apices. Posterior tibiae straight, cylindrical.

Length 6.5 mm., width 1 mm.

TYPE LOCALITY: Mafra, Santa Catharina, Brazil.

TYPE: In the Lionel Lacey Collection, deposited in the American Museum of Natural History.

Described from a single male collected during December, 1940, by A. Maller.

This species is allied to *Ommata tenuis* (Burmeister), but it differs from that species in having the elytra longer, extending to the tip of the fourth abdominal sternite, the basal segments of the antennae black, and the pronotum transversely flattened along the base and the anterior margin, with the surface sparsely, coarsely, and irregularly punctured.

***Ommata (Eclipta) brasiliensis*,
new species**

MALE: Slender, moderately shining; brownish black to reddish brown, the thorax reddish yellow, sometimes with the base and anterior margin black, and the palpi, apical segments of antennae, bases of femora, and tarsi and tibiae in part brownish yellow.

Head scarcely prolonged into a snout, densely, finely, rugosely punctate, sparsely clothed with short, recumbent, white hairs, with a few long, erect, inconspicuous hairs intermixed; eyes large, deeply emarginate, separated on the front by about one-half the width of the clypeus. Antenna slender, gradually expanded towards apex, but not serrate, extending to second abdominal sternite, sparsely clothed with long, erect, brown hairs.

Pronotum subcylindrical, distinctly longer than wide, slightly narrower at apex than at base, widest near middle; sides slightly, arcuately rounded; disk strongly

convex, narrowly, transversely flattened along base, more broadly transversely flattened along anterior margin; surface finely, confluent foveolate-punctate, sparsely, irregularly clothed with very long, erect, whitish hairs. Scutellum slightly, longitudinally concave, sparsely clothed with short, semi-erect, white hairs.

Elytra at base as wide as pronotum at middle, extending to middle of second abdominal sternite, strongly narrowed posteriorly, not dehiscent along sutural margins; sides broadly, arcuately constricted behind middles, the tips separately broadly rounded; surface finely, confluent foveolate-punctate, sparsely clothed with short, recumbent, inconspicuous hairs, with a few long erect hairs intermixed.

Abdomen beneath obsoletely granulose, finely, transversely rugose, rather densely clothed with moderately long, recumbent, white hairs, with a few long erect hairs intermixed; last visible sternite broadly rounded at apex. Prosternum finely, confluent foveolate-punctate posteriorly, impunctate along anterior margin, sparsely clothed with long erect and short recumbent, white hairs. Legs sparsely clothed with long, erect, brownish hairs. Anterior and middle legs short. Posterior legs long, slender. Femora strongly, abruptly clavate at apices. Posterior tibiae straight, cylindrical.

FEMALE: Differs from the male in having the eyes separated on the front by about the width of the clypeus.

Length 5.5-7 mm., width 1-1.25 mm.

TYPE LOCALITY: Corupa (Hansa Humboldt), Santa Catharina, Brazil.

TYPE: In the American Museum of Natural History.

ALLOTYPE: In the United States National Museum.

PARATYPE: In the Lionel Lacey Collection.

Described from three specimens (one male type). The type and allotype were collected at the type locality during October, 1945, and December, 1944, by A. Maller, and the paratype was collected at Nova Teutonia, Santa Catharina, Brazil, October 13, 1936, by Fritz Plaumann.

This species is allied to *Ommata vicina*

Melzer, but it differs from that species in having the elytra shorter, extending to the middle of the second abdominal sternite, uniformly reddish brown, with the tips broadly rounded, and the pronotum uniformly convex, reddish yellow, sometimes with the base and anterior margin black. The coloration of the legs is variable in this species.

***Acyphoderes auricapilla*, new species**

MALE: Rather short and robust, strongly shining; head and pronotum black; antenna black with seven apical segments brown; elytra greenish blue, vitreous, with well-defined black margins, which are considerably narrower along sutural regions; under side of body, anterior and middle legs, and posterior femora black; posterior tibiae pale yellow, with a narrow black band at bases, the yellow part clothed on all sides with a dense brush of long, erect, yellow hairs; posterior tarsi with basal segments yellow and apical segments reddish brown.

Head prolonged into a short snout, coarsely, sparsely, irregularly punctate, more coarsely, confluent punctate on occiput, with a narrow longitudinal groove between the eyes, sparsely clothed with short, semi-erect, inconspicuous hairs, with a few long erect hairs intermixed; eyes large, deeply emarginate, narrowly separated on the front. Antenna rather robust, extending to first abdominal sternite, expanded towards apex, serrate from fifth segment, sparsely clothed on under side with rather long semi-erect hairs.

Pronotum as wide as long, subequal in width at base and apex, widest at middle; sides slightly rounded at middles, constricted at bases; disk slightly uneven and vaguely flattened, narrowly, transversely flattened along base; surface coarsely, confluent foveolate-punctate, densely clothed with short, erect, black hairs, with a few long erect hairs intermixed. Scutellum densely clothed with short, erect, black hairs.

Elytra at base distinctly wider than pronotum, extending to base of fourth abdominal sternite, strongly narrowed behind basal thirds, strongly dehiscent al-

sutural margins, narrowly rounded at apices; surface very sparsely, finely punctate, and clothed with a few short, erect, black hairs on vitreous areas, coarsely, confluent punctate on black margins.

Abdomen beneath finely, densely, irregularly punctate, rather densely clothed with short, recumbent, brownish hairs, with a few long erect hairs intermixed; last visible sternite slightly flattened and truncate at apex. Mesosternum and metasternum rather densely clothed with long and short, semi-erect, brown hairs, and irregularly ornamented with patches of rather long, dense, recumbent, white hairs. Prosternum very coarsely, irregularly punctate, sparsely clothed with long, erect, brown hairs. Anterior and middle legs short; femora strongly, abruptly clavate towards apices. Posterior legs long, slender; femora gradually, moderately clavate towards apices; tibiae straight, cylindrical, uniformly expanded on apical four-fifths.

Length 15 mm., width 3.5 mm.

TYPE LOCALITY: Horqueta, Paraguay.

TYPE: In the Lionel Lacey Collection, deposited in the American Museum of Natural History.

Described from a single male collected December 27, 1934, by A. Schulze.

This species differs from the other described species of *Acyphoderes*, in being uniformly black, with the vitreous areas of the elytra greenish blue, and in having the basal segments of the posterior tarsi, and posterior tibiae (except black band at bases) yellow, the tibiae ornamented with a dense brush of long, erect, yellow hairs.

Odontocera alboscutellata,
new species

FEMALE: Elongate, rather slender, strongly shining; head, pronotum, basal segment of antenna, under side of body, and apical halves of posterior femora red or reddish brown; elytra pale vitreous, with sutural and lateral margins black; antenna (except basal, eighth, and ninth segments), and anterior and middle legs (except bases of femora) black or brownish black; posterior tibiae and bases of all femora yellowish brown; posterior tarsi and eighth and ninth antennal segments whitish.

Head scarcely prolonged into a snout, finely, sparsely, irregularly punctate, sparsely clothed with very short, inconspicuous hairs; eyes large, deeply emarginate, separated on the front by about the width of the clypeus. Antenna extending to tip of elytron, slender, cylindrical, gradually expanded towards apex but not serrate.

Pronotum subcylindrical, distinctly longer than wide, subequal in width at base and apex, widest at middle; sides slightly, arcuately rounded at middles, vaguely constricted near bases and apices; disk moderately convex, slightly uneven, transversely flattened along base and anterior margin; surface rather coarsely, irregularly punctate, with an elongate, median, smooth space, clothed with a few inconspicuous, erect hairs on disk, and densely clothed along lateral margins and base in front of scutellum with rather long, recumbent, white hairs. Scutellum densely clothed with long, recumbent, white hairs.

Elytra at base as wide as pronotum at middle, extending to middle of last visible abdominal sternite, strongly narrowed behind basal thirds, not dehiscent along sutural margins, separately, broadly rounded at apices; surface coarsely, sparsely punctate, sparsely clothed on vitreous areas with short, inconspicuous, erect hairs, and ornamented along lateral and sutural margins with a narrow vitta of dense, short, recumbent, white hairs.

Abdomen beneath finely, densely punctate, with a few coarse punctures intermixed, sparsely clothed at middle with short, recumbent, inconspicuous hairs, and with patches of longer, dense, white hairs towards sides. Prosternum coarsely, sparsely punctate, sparsely clothed with short, recumbent, white hairs. Anterior and middle legs short; femora strongly clavate. Posterior legs long and slender, clothed with rather short, erect, yellow hairs; femora strongly clavate towards apices; tibiae straight, cylindrical.

Length 9.5 mm., width 2 mm.

TYPE LOCALITY: Cauna, Santa Catharina, Brazil.

TYPE: In the American Museum of Natural History.

PARATYPE: In the United States National Museum.

Described from two females (one type) collected during November and December, 1945, by A. Maller.

This species is allied to *Odontocera albitarsis* Melzer, but it differs from the description given for that species in having the head, basal segment of the antenna, under side of the body, and the apical halves of the posterior femora reddish or reddish brown, the posterior tibiae yellowish brown, the abdomen sparsely pubescent, the lateral and sutural margins of the elytra ornamented with a vitta of dense white hairs, and the tips of the elytra broadly rounded.

Odontocera typhoeus, new species

FEMALE: Rather broadly elongate, moderately shining; head, pronotum, and antennae black; elytra pale yellow, vitreous, with lateral and sutural margins black; under side of body and legs (except bases of femora which are yellow) black or brownish black, with distinct greenish and purplish reflections in different lights.

Head prolonged into a short snout, coarsely, sparsely, irregularly punctate, with a narrow, longitudinal, median groove on front, sparsely clothed with short, erect, inconspicuous hairs; eyes large, deeply emarginate, separated on the front by about one-half the width of the clypeus. Antenna short (two apical segments missing), rather robust, expanded towards apex, serrate from fifth segment.

Pronotum subcylindrical, distinctly longer than wide, subequal in width at base and apex; sides nearly parallel; disk uneven, broadly, transversely flattened on apical third, with a narrow, deep groove along anterior margin, and a transverse, angulated, broad groove near base, and with five more or less distinct tubercles on median part of disk; surface coarsely, sparsely, irregularly punctate, clothed with a few long, erect, inconspicuous hairs. Scutellum densely clothed with recumbent white hairs.

Elytra at base slightly wider than pronotum, extending to middle of fourth abdominal sternite, slightly dehiscent along

sutural margins, strongly narrowed behind basal thirds, narrowly subtruncate at apices; surface glabrous, vitreous areas impunctate, black margins coarsely, densely punctate.

Abdomen beneath finely, sparsely punctate, sparsely clothed with short, semi-erect, inconspicuous hairs; last visible sternite narrow, subtruncate at apex. Prosternum coarsely, sparsely punctate, sparsely clothed with long semi-erect hairs. Anterior and middle legs short. Posterior legs long, slender. Femora strongly, abruptly clavate at apices. Posterior tibiae straight, cylindrical, slightly expanded towards apices.

Length 19 mm., width 3.5 mm.

TYPE LOCALITY: Brazil, no definite locality.

TYPE: In the American Museum of Natural History.

Described from a single female from the W. Schaus Collection.

This species is allied to *Odontocera flavicauda* Bates, but it differs from the description given for that species in having the antenna entirely black and not half so long as the body, the tips of the elytra truncate, the under side of the body brownish black with a distinct greenish or purplish reflection in different lights, and the basal halves of the posterior femora pale yellow.

Stenopseustes gibbicollis, new species

FEMALE: Elongate, subcylindrical; head (except triangular spot on occiput), sides of pronotum, under side of body, anterior and middle femora, and basal halves of posterior femora brownish yellow; triangular spot on head behind eyes, antennae, disk of pronotum, tibiae, tarsi, and apical halves of posterior femora black; elytra black, each with a median, yellowish brown vitta on basal half.

Head not produced into a snout, densely, coarsely, shallowly punctate, finely granulose, with a distinct longitudinal groove extending from clypeus to occiput, sparsely clothed with short, erect, inconspicuous hairs, with a few long erect hairs intermixed; eyes moderately large, very deeply emarginate, very widely separated on the front. Antenna rather slender, gradually

expanded towards apex, but not serrate, extending to apex of second abdominal sternite, basal segments rather densely ciliate on under side with long, erect, brown hairs; first segment short, robust, slightly clavate; third segment one-third longer than fourth.

Pronotum subcylindrical, slightly longer than wide, subequal in width at base and apex; sides parallel; disk uneven and longitudinally gibbose at middle; surface densely, finely scabrous on discal black area, finely, densely granulose and obsoletely punctate on yellow areas, sparsely clothed with short and long, erect, inconspicuous hairs. Scutellum finely, densely granulose, broadly rounded at apex, sparsely clothed with short, erect, inconspicuous hairs.

Elytra at base distinctly wider than pronotum, extending to apex of fourth abdominal sternite, strongly narrowed posteriorly, not dehiscent along sutural margins; sides broadly, arcuately constricted behind basal fourths, the tips separately, narrowly rounded; surface densely, finely rugose or punctate, with a few inconspicuous coarse punctures intermixed, densely clothed with short, recumbent, whitish hairs, with a few long erect hairs intermixed.

Abdomen beneath densely, finely, obsoletely rugose, coarsely, sparsely, irregularly, shallowly punctate, sparsely clothed with short semi-erect, and long erect, yellow hairs; last visible sternite obtusely angulated at apex. Prosternum finely, densely, indistinctly punctate, densely clothed with short, recumbent, yellow hairs. Legs rather densely clothed with long, erect, black hairs. Anterior and middle legs moderately long. Posterior legs long, slender. Femora strongly, abruptly clavate towards apices. Posterior tibiae cylindrical.

Length 17 mm., width 3.5 mm.

TYPE LOCALITY: Corupa (Hansa Humboldt), Santa Catharina, Brazil.

TYPE: In the American Museum of Natural History.

Described from a single female collected during November, 1944, by A. Maller.

This species is allied to *Stenopseustes aeger* Bates, but it differs from the description given for that species in having the antennae entirely black, the pronotum distinctly narrower than the elytra, with a large, broad, distinct, median, black vitta, the tibiae, tarsi, and apical halves of the posterior femora black, and the last visible abdominal sternite obtusely angulated at the apex.

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TWO NEW FISHES, AN *EQUES* AND A *HOLANTHIAS*, FROM PERU

BY OTIS BARTON

In Talara, Peru, during the months of January to April, 1946, I collected 48 species of shore fishes and 41 deep sea fishes. The shore fishes were procured by the pescadores, who fish on the banks west of Talara at depths up to 250 feet. The most interesting of these are an undescribed species of *Eques*, and an undescribed species referable, according to Weber and De Beaufort, to *Holanthias*.

Eques lanfeari, new species

DESCRIPTION OF TYPE: No. 17081, American Museum of Natural History, from banks 250 feet deep off Talara, Peru.

strongly elevated; anterior profile steep, but nearly straight; head compressed; snout blunt, not protruding beyond premaxillaries, with pores and slits, 3.0 in head; eye, 4.7; interorbital, 3.7. Mouth nearly horizontal, inferior; the maxillary about reaching middle of eye, 2.6 in head; tip of lower jaw with flat fleshy knob; posterior nostril oval, anterior somewhat triangular and smaller; preopercle with serrated membranous border. Gill-rakers very short, nine not counting rudiments on lower limb of first arch; pseudobranchiae well developed. Teeth in wide bands on both jaws, the outer ones in the upper jaw enlarged, as

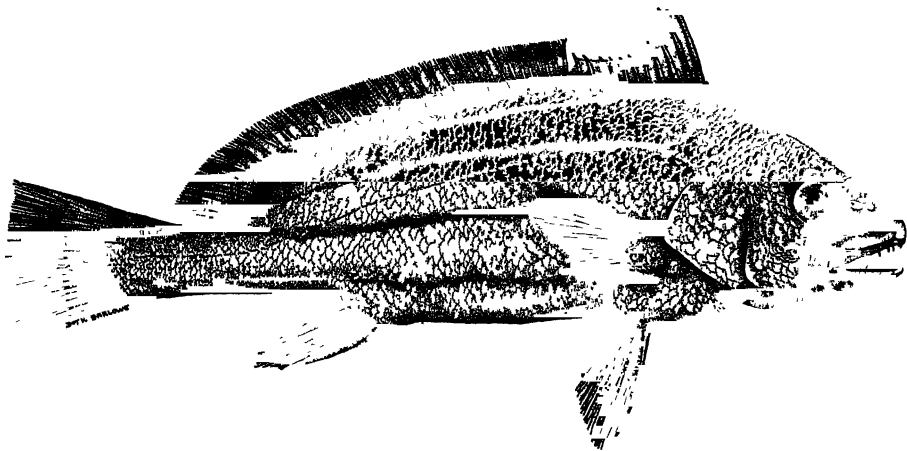


Fig. 1. *Eques lanfeari*, new species. Type.

Length to base of caudal, 245 mm. (290 mm. total). Head in this length, 3.2; depth, 2.7. D. XII, 35-36; A. II, 7; scales in 80 transverse series above lateral line, 12 rows between lateral line and middle of first dorsal.

Body deep, much compressed; the back

long as anterior nostril; those of the lower jaw about equal in size. Scales strongly ctenoid; lateral line (not distinct) rather strongly arched, becoming horizontal on caudal peduncle, the depth of which is 3.5 in head. Second dorsal, caudal, and anal scaly; dorsal fins barely continuous;

spinous dorsal short, the first spine very short, the second and third high, the third 1.8 in head; soft dorsal very long and rather low; caudal fin rounded; anal small, the second spine enlarged, 2.2 in head, as long as longest soft rays, but not reaching their tip; ventrals 1.6 in head; pectorals 1.7.

Color gray, purplish along back, a little lighter on belly; all fins dusky at edges;

N.H. No. 12069), in color; scale count; in having a few more rows of scales on operculum and preoperculum; shape of nostrils; and greater enlargement of front teeth. From *E. fuscovittatus*, Kendall and Radcliffe, 1912, it differs notably in color, and has a more pointed spinous dorsal, and fewer gill-rakers.

Named for Mr. Lanfear B. Norrie of New York City.

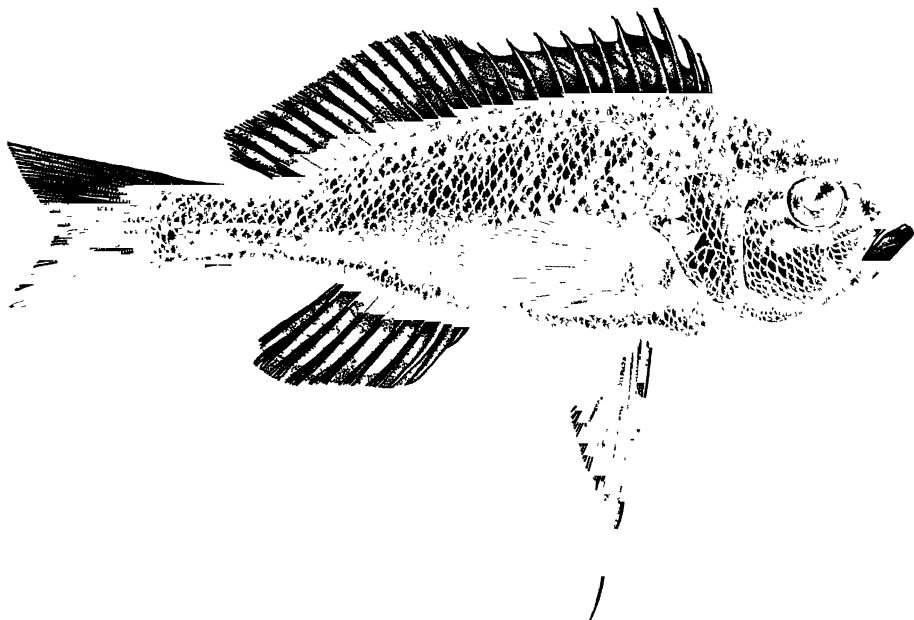


Fig. 2. *Holanthias sechurae*, new species

snout, opercles, and preopercles darker; four distinct, horizontal, dark stripes, the first about one-third of the pupil in width, starting below middle of first dorsal and running along base of fin to middle of soft dorsal; the second, about one-half of the pupil in width, starting about the length of the snout below the first dorsal spine and curving backwards to base of third hindmost ray of soft dorsal; the third, slightly wider, from back of opercular angle to upper third of peduncular base; the fourth, a little narrower, starting a little behind lower pectoral base and running back to above posterior anal base.

This specimen differs from an *E. acuminatus* with which it was compared (A.M.

Holanthias sechurae, new species¹

Head completely scaled, including snout and maxillary, only premaxillary and upper border and tip of mandible scaleless. Tongue with a considerable patch of fine, granular teeth. Small canine teeth at the front of the upper jaw and front and sides of the lower jaw, those at front of lower jaw projecting obliquely forward. Preopercle finely serrate. Lateral line with a sharp downward flexure under posterior dorsal rays.

¹ This species is close to *Anthias gordensis* Wade (1946 Hancock Pacific Expeds., vol 9, pt 8, p 225, pl 32) from off Cape San Lucas, the description of which came to hand after Mr. Barton had turned in his manuscript, and was on an expedition to the Great Barrier Reef, Australia.—J. T. N.

DESCRIPTION OF TYPE: No. 17082, American Museum of Natural History, obtained from fishermen at Talara, Peru, exact locality uncertain. Length to base of caudal, 188 mm. (235 mm. total). Depth in this length, 3.1; head, 3.1. D. X, 15; A. III, 7; scales, 55-56, $2\frac{1}{2}/17$; 1.1. 52-53; P. 19.

Snout short, a little greater than diameter of eye, which is 4 times in length of head measured to point of opercular spine, and equals interorbital width; lower jaw projecting; maxillary extending just beyond center of eye, the width of its distal extremity two-thirds the diameter of eye; a blunt spine at angle of operculum, and two sharp spines below it; middle opercular spine the longest of the three. Gill-rakers long and slender, 26 on lower part of anterior arch. Dorsal originating above middle of operculum; its spines increasing in length to third, then slowly decreasing; the third spine 2.3 in head; dorsal spines with short membranous filaments extending little if any beyond their tips; soft dorsal not scaly at base, gently convex above, pointed behind, its mid-rays the longest, longer than dorsal spines; no notch between spinous and soft portions. Pectoral 1.2 in head; ventrals with filamentous first and second rays; the second ray reaching past the anal spines, 2.7 in length. Anal spines strong, first short, second the strongest and a little shorter than third, the

third equal to fourth dorsal spine; anal paired with soft dorsal, but the rays a little longer. Caudal forked, outer rays not produced, 1.4 in head; depth of peduncle 2.9 in head. Lateral line bent down at an obtuse angle below last dorsal rays, and four scales later bent back again at an equal obtuse angle to the horizontal along the middle of the peduncle; the lateral line skips the middle of the three intermediate scales. Color of type specimen masked by purple stain.

A second specimen 192 mm. in total length not affected by stain is yellowish with brown mottling above, a little paler below, fins all pale. It shows traces of three radiating dark lines behind the eye, each line about as wide as pupil, a dark patch between the eyes extending onto snout, and a dark line in front of the eye carried forward onto tip of lower jaw.

This specimen differs from the type in minor particulars, presumably within the range of individual variation, the most notable being two small, flat, backwardly directed spines at the angle of the preopercle, whereas that of the type is evenly serrate, the serrae at the angle only slightly enlarged.

Mouth of the type is wide open, and the head distorted. In the figure, configuration of the head, as well as color, is from this second specimen.

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STUDIES OF THE PHALANGID FAUNA OF TRINIDAD

BY CLARENCE J. AND MARIE L. GOODNIGHT¹

During the past few years, the authors have been so fortunate as to obtain a considerable collection of phalangids from Trinidad. These were presented to them by Messrs. Robert Ingle and R. H. Montgomery.

These collections contained not only specimens of previously described species but a number of new forms. Thus it has been possible for the authors to study all forms so far known from Trinidad.

For the first time the subfamily Tricommatinae (Phalangodidae) was found in Trinidad. Two species were represented in the collections. The Phalangodinae, Cosmetinae, two subfamilies of the Gony-

leptidae, and one member of the suborder Palpatores were also represented.

The collections made by Ingle were confined to a small valley in southwest Trinidad known locally as Tucker Valley. Ingle writes that most of the small phalangids were obtained by sifting under sticks and logs which were partially decomposed. The area was an abandoned cocoa plantation which was covered with thick tropical vegetation.

The authors wish to express their appreciation to these two men for making the collections available for their study.

All holotypes of new species are deposited in the collection of the American Museum of Natural History.

SUBORDER LANIATORES THORELL

PHALANGODIDAE Simon

Phalangodinae Roewer

Kalina tuberculata, new species

Figure 4

HOLOTYPE: Total length of body, 2.1 mm. Cephalothorax, 0.7 mm. Width of body at widest portion, 1.7 mm.

	I	II
Trochanter	0.2 mm.	0.3 mm.
Femur	0.9	1.4
Patella	0.4	0.5
Tibia	0.7	1.2
Metatarsus	1.0	1.4
Tarsus	0.7	1.4
Total	3.9 mm.	6.2 mm.
	III	IV
Trochanter	0.3 mm.	0.3 mm.
Femur	1.0	1.6
Patella	0.4	0.6
Tibia	0.8	1.4
Metatarsus	1.3	2.0
Tarsus	0.8	1.0
Total	4.6 mm.	6.9 mm.

Dorsum with five areas, the boundaries of which are parallel. First area without a median line. Dorsal scute smooth except for an irregular transverse row of fine granulations across each area. A row of lateral granulations also present on the dorsal scute. Free tergites each with a transverse row of small tuberculations. Cephalothorax smooth; eye tubercle removed from the anterior margin, a pair of very small spines above the eye tubercle. A slight elevation on the cephalothorax anterior to the eye tubercle. Anal operculum covered with granulations. Free sternites with scattered hairs, a few small tuberculations on the first coxa, second coxa with some dorsal tuberculations, third with some very small anterior and posterior teeth. Remainder of venter and all coxae with scattered hairs. Spiracles visible.

Legs clothed throughout with scattered hairs, small tuberculations more or less arranged in rows on the femora. These are somewhat larger on the anterior margin of

¹ Department of Biology, Purdue University, West Lafayette, Indiana.

the first femur. Metatarsi not divided into astragali and calcanei. Tarsal segments: 3-7-5-6. Distitarsus of first tarsus with two segments, second with three.

Palpus: trochanter, 0.2 mm. long; femur, 0.5; patella, 0.2; tibia, 0.4; and tarsus, 0.3. Total length, 1.6 mm. Palpus armed retrolaterally as in figure; prolaterally the femur has a median apical spine; the patella has a median apical spine; the tibia and tarsus armed as on the retrolateral surface.

Chelicera normal, with scattered hairs.

Body reddish brown with darker brown mottlings. Many of these mottlings on the cephalothorax. Dorsal scute bordered with darker brown; with a transverse dark stripe across each area, giving an appearance of alternating lighter and darker stripes. Free tergites, anal operculum, and sternites darker. Legs with much dark brown mottling excepting the trochanters which are light. Palpus and chelicera mottled.

TYPE LOCALITY: Holotype from Tucker Valley, near Navy Base in southwest Trinidad, November, 1944 (R. Ingle).

Kalina tuberculata, new species, is related to *Kalina parallela* Goodnight and Goodnight, differing by lacking the elongate fourth leg of *K. parallela* and also by having more tuberculations on the dorsum and free tergites.

Pellobunus longipalpus, new species

Figure 10

HOLOTYPE: Total length of body, 2.3 mm. Cephalothorax, 0.8 mm. Width of body at widest portion, 1.4 mm.

	I	II
Trochanter	0.3 mm.	0.4 mm.
Femur	1.7	4.3
Patella	0.6	0.9
Tibia	1.2	4.1
Metatarsus	1.9	4.5
Tarsus	1.0	2.7
Total	6.7 mm.	16.9 mm.
	III	IV
Trochanter	0.4 mm.	0.4 mm.
Femur	1.7	2.2
Patella	0.6	0.7
Tibia	1.3	1.8
Metatarsus	1.7	2.3
Tarsus	1.3	1.9
Total	7.0 mm.	9.3 mm.

Dorsum finely granulate. Dorsal scute with five areas, the boundaries of which are parallel, first area without a median line. A row of small tubercles across each area, a row of larger hair-tipped tubercles at the posterior boundary of the fifth area and across each free tergite. Eye tubercle rounded above, low, covered with granulations, removed from the anterior margin of the cephalothorax, approximately in the center of the cephalothorax. Anal operculum tuberculate. Each free sternite with a transverse row of tubercles, coxae with scattered tubercles and hairs, tubercles larger on the first coxa. Anterior and posterior rows of teeth on the third coxa. Tuberculations of the fourth coxa visible from above. Spiracles visible, but narrow.

Legs clothed throughout with hairs. Small tuberculations scattered over the femora, patellae, and tibiae; metatarsi not divided into astragali and calcanei. Tarsal segments: 4-7-5-6. Distitarsus of first tarsus with two segments, second with three.

Palpus: trochanter, 0.4 mm. long; femur, 1.9; patella, 1.3; tibia, 1.1; tarsus, 0.8 mm. Total length, 5.4 mm. Palpus tremendously elongate. Armed retrolaterally as in figure 10. Prolaterally armed as follows: femur with a median spine, no apical median or apical dorsal spine present; patella with a small median apical spine; tibia with three spines; tarsus with two.

Chelicera with scattered hairs, proximal segment with a dorsal elevation.

Body reddish brown with darker brown mottlings on the cephalothorax, appendages lighter. Some darker brown mottlings on the femur and patella of the palpus and on the legs.

TYPE LOCALITY: Holotype from St. Augustine, Trinidad, October 19, 1944 (T. S. Jones).

This species differs from other members of the genus *Pellobunus* by having greatly enlarged palpi.

Pellobunus trispinatus, new species

Figures 1-3

MALE HOLOTYPE: Total length of body, 2.2 mm. Cephalothorax, 0.8 mm. Width of body at widest portion, 1.4 mm.

	I	II
Trochanter	0.2 mm.	0.3 mm.
Femur	1.3	3.4
Patella	0.4	0.8
Tibia	1.0	3.4
Metatarsus	1.4	3.9
Tarsus	0.8	1.1
Total	5.1 mm.	12.9 mm.

	III	IV
Trochanter	0.3 mm.	0.4 mm.
Femur	1.4	1.8
Patella	0.4	0.5
Tibia	1.1	1.6
Metatarsus	1.5	2.1
Tarsus	0.8	1.3
Total	5.5 mm.	7.7 mm.

Body pyriform, boundaries of areas parallel. First area without a median line. Entire dorsum somewhat granulate, with a row of hair-tipped small tubercles across each area and each free tergite. Eye tubercle slightly removed from the anterior margin of the cephalothorax, rounded above, covered with small scattered tuberculations. A row of larger tubercles along the lateral margin of the dorsal scute. Anal operculum tuberculate, free sternites each with a transverse row of small tuberculations. Coxae thickly covered with small tuberculations and scattered hairs. Fourth coxa widened, the granular surface visible from above. A row of larger hair-tipped tubercles across the first coxa, third coxa with anterior and posterior rows of teeth. Spiracles visible.

Legs clothed throughout with scattered hairs. Trochanters covered with small granulations, globular in shape. Femora covered with small hair-tipped tubercles. Remaining segments without tuberculations, but sometimes a few granulations present on the fourth tibia. Tarsi with investing hairs. Metatarsi not divided into astragali and calcanei. Tarsal segments: 4-6-5-6. Distitarsus of first tarsus with three segments, second with three. Some specimens among those studied had the second leg much elongated.

Palpus: trochanter, 0.3 mm. long; femur, 0.7; patella, 0.4; tibia, 0.5; and tarsus, 0.4. Total length, 2.3 mm. Palpus armed retrolaterally as in figure 3. Pro-laterally armed as follows: femur with a median apical spine; patella with a me-

dian apical spine; tibia with three spines; and tarsus with two.

Chelicera normal, with scattered hairs. A slight dorsal elevation on the first segment.

Dorsum, venter, and coxae reddish brown, with some darker brown mottlings particularly conspicuous on the cephalothorax. Trochanters of all appendages yellowish, lighter; but in some specimens the color of the trochanters was nearly as dark as that of the legs. Legs darker reddish brown, mottled. Tarsi lighter. Femur and patella of palpus dark reddish brown, tibia and tarsus lighter.

FEMALE: Total length of body, 1.9 m. Cephalothorax, 0.7 mm. Width of body at widest portion, 1.4 mm.

Identical in appearance with the male.

TYPE LOCALITY: Male holotype and male and female paratypes from Tucker Valley, near Navy Base in southwest Trinidad, November, 1944 (R. Ingle).

This species differs from *Pellobunus insularis* Banks by having three spines on the inner margin of the tibia of the palpus; *P. insularis* Banks has only two.

Tricommatainae Roewer

TRINELLA, NEW GENUS

Dorsum with five areas, the boundaries of which are parallel. First area without a median line. First to fourth areas each with low, median, paired tubercles. Femur and patella of palpus each with a median apical spine, but without dorsal apical spines. Tarsal segments all number more than six. Distitarsus of first tarsus with three segments, of second three. Spiracles visible. Eye tubercle unarmed and removed from the anterior margin of the cephalothorax.

GENOTYPE: *Trinella intermedia*, new species.

Trinella is most closely related to *Vima*. It differs by having low, median, paired tubercles on the dorsal areas.

Trinella intermedia, new species

Figure 8

HOLOTYPE: Total length of body, 4.3 mm. Cephalothorax, 1.2 mm. Width of body at widest portion, 2.4 mm.

	I	II
Trochanter	0.4 mm.	0.7 mm.
Femur	5.7	12.6
Patella	0.7	1.4
Tibia	4.3	8.4
Metatarsus	8.1	15.6
Tarsus	1.4	6.1
Total	20.6 mm.	44.8 mm.

	III	IV
Trochanter	0.7 mm.	0.7 mm.
Femur	9.8	13.2
Patella	1.6	1.6
Tibia	5.7	7.5
Metatarsus	8.4	15.0
Tarsus	2.8	3.6
Total	29.0 mm.	41.6 mm.

Dorsum with five areas, the boundaries of which are parallel, first area without a median line. Dorsum smooth except for the paired low tubercles of the dorsal areas. These paired tubercles are very low. A transverse row of very small tubercles across the fifth area and each free tergite. The lateral portion of the dorsal scute bends at an abrupt angle, causing a prominent keel to be present. Eye tubercle low, unarmed, in the median portion of the cephalothorax. Anal operculum with only a few scattered hairs, a transverse row of hair-tipped tuberculations across each free sternite. Spiracle visible. Coxae smooth except for a transverse row of tubercles across the first and the fourth, a few small tubercles on the second, a dorsal posterior spine on the fourth coxa.

Legs smooth except for a few irregularly scattered hairs. All legs long and slender with the first one being particularly slender. Tarsal segments: 8-24-8-8. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 0.6 mm.; femur, 1.2; patella, 0.8; tibia, 0.9; and tarsus, 0.9. Total length, 4.4 mm. Palpus armed retrolaterally as in figure 8. Prolaterally armed as follows: the femur has a median apical spine; the patella has a median apical spine; the tibia has three spine-bearing tubercles; the tarsus has three.

Chelicera normal, with scattered hairs, tuberculations on the proximal segment.

Color of entire body and appendages reddish brown, with darker brown mottlings

which are particularly numerous on the dorsum.

TYPE LOCALITY: Holotype from St. Augustine, Trinidad, November 12, 1944 (R. H. Montgomery).

Vima albiornata, new species

Figure 5

HOLOTYPE: Total length of body, 3.6 mm. Cephalothorax, 0.8 mm. Width of body at widest portion, 2.2 mm.

	I	II
Trochanter	0.6 mm.	0.6 mm.
Femur	5.0	8.8
Patella	0.7	1.2
Tibia	3.8	4.8
Metatarsus	6.6	10.2
Tarsus	1.4	1.
Total	18.1 mm.	27.4 mm.

	III	IV
Trochanter	0.4 mm.	0.6 mm.
Femur	12.8	11.9
Patella	1.1	1.4
Tibia	9.8	6.5
Metatarsus	1.1	13.8
Tarsus	6.0	3.0
Total	31.2 mm.	37.2 mm.

Dorsum with five areas, the boundaries of which are parallel. First area without a median line. Dorsal scute covered with small granulations, a few irregularly scattered larger granulations also present. Eye tubercle low, unarmed, towards the posterior portion of the cephalothorax. A transverse row of larger granulations across the posterior margin of the fifth area and the first free tergite. Posterior to the eye tubercle is an elevation equal in height to the eye tubercle, but somewhat constricted in the middle. Anal operculum smooth, a transverse row of granulations across each free sternite. Coxae granulate, several enlarged tubercles present on the first coxa, only a few anterior and posterior teeth on the third coxa. Spiracles visible.

Legs long and slender, smooth except for scattered hairs. Tarsal segments: 9-?-7-9. Distitarsus of first tarsus with three segments.

Palpus: trochanter, 0.4 mm. long; femur, 1.1; patella, 0.6; tibia, 0.7; and

tarsus, 0.7. Total length, 3.5 mm. Palpus armed retrolaterally as in figure 5. Prolaterally armed as follows: femur and patella each with a median apical spine; tibia with three spines, the distal one being the smallest; tarsus with three spines, the distal one also being the smallest.

Chelicera normal, with scattered hairs, proximal segment with a few scattered tubercles, some hair-tipped tubercles on the anterior portion of the second segment. Claws strongly curved towards the median line.

Dorsum reddish brown, the elevation behind the eye tubercle white: this white patch extends down from the elevation to the first abdominal segment where it ends with a few white flecks. A white dot in the median portion of the third free tergite, a large white spot in the median portion of the dorsal part of the anal operculum. Venter and coxae reddish brown, legs lighter brown with distal portion of the femora and patellae dark brown. Distal portion of tibiae and proximal portion of metatarsi of second to fourth legs each with a light band; darker brown areas surround these light bands. The first leg small and thread-like, without darker areas. Chelicera and palpus reddish yellow, lighter than the body, chelical claws darker brown.

TYPE LOCALITY: Holotype from Diego Martin, November 9, 1944 (R. H. Montgomery).

Vima albiornata, new species, differs from *Vima insignis* Hirst by having the white raised area posterior to the eye tubercle rather than on the second and third areas of the dorsum.

COSMETIDAE Simon

Cosmetinae Cambridge

Cynortula granulata Roewer

Figure 6

Cynortula granulata ROEWER, 1912, Arch. Naturgesch., vol. 78, sect. A, no. 10, p. 46; 1923, Die Weberknechte der Erde, p. 323, fig. 359.

MALE: Total length of body, 4.2 mm. Cephalothorax, 1.6 mm. Width of body at widest portion, 3.1 mm.

	I	II
Trochanter	0.5 mm.	0.6 mm.
Femur	2.4	5.2
Patella	0.8	1.0
Tibia	1.6	3.8
Metatarsus	2.6	5.0
Tarsus	1.7	3
Total	9.6 mm.	19.2 mm.

	III	IV
Trochanter	0.6 mm.	0.6 mm.
Femur	3.8	5.4
Patella	1.1	1.2
Tibia	2.1	3.2
Metatarsus	3.6	3.8
Tarsus	2.0	1.9
Total	13.2 mm.	16.1 mm.

Entire dorsum including the eye tubercle covered with many small tuberculations which are more numerous on the median and lateral portions of the scute. A transverse row of these tuberculations across the posterior margin of the fifth area and each free sternite. Median paired tubercles on the first and third areas. In some specimens the tubercles of the third area are much enlarged. Anal operculum tuberculate, a transverse row of small tuberculations across each free sternite. Coxae with scattered hairs and granulations; a transverse row of large tubercles across the first coxa. Anterior and posterior rows of teeth on the second coxa.

Legs with scattered hairs, granulations present on the femora and patellae. Third and fourth legs not enlarged over the first and second. Tarsal segments: 6-10-7-7. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 0.5 mm. long; femur, 1.1; patella, 0.8; tibia, 1.1; and tarsus, 0.5. Total length, 4.0 mm. Palpus characteristically flattened, a row of teeth on the ventral margin of the femur.

Chelicera normal.

Dorsum reddish brown, with a pale white pencilling arranged as in figure 6. Appendages somewhat lighter.

RECORDS: Tucker Valley, November, 1944 (R. Ingle); Tucker Valley, September, 1944 (R. Ingle); Sangre Grande, December 6, 1944 (R. M. Montgomery); and El Tucuche, November, 1944 (R. M. Montgomery).

***Paecilaemainglei*, new species**

Figure 7

MALE: Total length of body, 5.6 mm.
Cephalothorax, 1.8 mm. Width of body
at widest portion, 4.4 mm.

	I	II
Trochanter	0.7 mm.	0.8 mm.
Femur	4.4	9.8
Patella	0.7	1.5
Tibia	2.7	7.8
Metatarsus	4.9	11.2
Tarsus	2.4	5.5
Total	15.8 mm.	36.6 mm.

	III	IV
Trochanter	0.7 mm.	0.8 mm.
Femur	7.4	9.7
Patella	1.5	1.6
Tibia	3.6	5.5
Metatarsus	6.8	10.2
Tarsus	3.3	3.8
Total	23.3 mm.	16.0 mm.

Dorsum smooth, arched in the region of the third area. Paired tubercles on the first area, median paired spines on the third. The spines of the third area are very straight and quite heavy at the base. A transverse row of very small tubercles across the posterior margin of the fifth area and across each free tergite. Eye tubercle low. Anal operculum smooth, a transverse row of small hair-tipped tubercles across each free sternite. Coxae with scattered hairs, third coxa with an anterior and posterior row of teeth, a transverse row of prominent tubercles across the first coxa.

Legs with scattered hairs, otherwise smooth. Basal segments of third and fourth legs not enlarged over those of the first and second. Legs long and slender. Basitarsus of first tarsus not enlarged. Tarsal segments: 7-14-10-11. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 0.7 mm. long; femur, 1.4; patella, 0.9; tibia, 1.7; and tarsus, 0.6. Total length, 5.3 mm. Palpus characteristically flattened, a ventral row of teeth on the femur.

Chelicera slightly enlarged.

Dorsum light yellowish brown, darker brown patches in the anterior third of the cephalothorax and around the eye tubercle. A darker brown portion also present around

the paired tubercles of the first area. Basal area of the spines of the third area darker brown, spines dark brown. Dorsum covered with scattered white spots. These spots are more numerous at the lateral portion of the scute; a few of the spots extend onto the eye tubercle. A transverse row of white spots across each free tergite. Anal operculum without white markings. Venter and coxae reddish brown, legs lighter brown. Palpus and chelicera with much darker brown mottling, making them appear somewhat darker than the legs.

FEMALE: Total length of body, 5.5 mm. Cephalothorax, 1.6 mm. Width of body at widest portion, 4.1 mm.

Similar in appearance to male, but lacking the enlarged chelicera.

TYPE LOCALITY: Male holotype and male and female paratypes from Tucker Valley, southwest Trinidad, November, 1944 (R. Ingle); additional male and female paratypes from El Tucuche, November, 1944 (R. H. Montgomery); and Diego Martin, September 12, 1944 (R. H. Montgomery). One paratype from St. Anne, July 6, 1926, in the collection of Dr. Alexander Petrunkevitch of Yale University.

This species is related to *Paecilaema guttatum* Roewer. It differs in the color pattern of the dorsum. *P.inglei* lacks the transverse white line behind the spines of the third area which is present in *P. guttatum*.

GONYLEPTIDAE Sundevall**Cranainae Roewer*****Cranellus montgomeryi*, new species**

Figures 11-12

FEMALE: Total length of body, 3.8 mm. Cephalothorax, 1.4 mm. Width of body at widest portion, 3.1 mm.

	I	II
Trochanter	0.5 mm.	0.6 mm.
Femur	2.5	5.5
Patella	0.7	1.0
Tibia	1.2	3.8
Metatarsus	2.4	4.0
Tarsus	1.7	4.3
Total	9.0 mm.	19.2 mm.

	III	IV
Trochanter	0.6 mm.	0.7 mm.
Femur	3.9	4.7
Patella	1.0	0.5
Tibia	2.0	2.3
Metatarsus	3.1	4.8
Tarsus	1.8	1.4
Total	12.4 mm.	14.4 mm.

Dorsal scute with four areas. First area with a median line. First area with median paired spines; in addition, on either side, four small spines arranged in a semicircle anterior to the median spine. Second area without median armature, but with a row of seven or eight small spines. Third area with a pair of long acute spines, and in addition seven or eight smaller spines clumped around the base of each large spine. Fourth area without median armature, but with a small tubercle near the lateral margin. First free tergite without median armature, but with a small tubercle near the lateral margin. Second free tergite with only a few very small tubercles, third free tergite with a median pair of spines and a few small tubercles. Eye tubercle in the middle of the cephalothorax, a small spine over each eye. On either side two small spines posterior and laterad to the eye tubercle. Anal operculum with scattered hairs, free sternites each with a transverse row of hair-tipped tubercles. Coxae with scattered hair-tipped tubercles somewhat arranged in rows, largest ones on the first coxa. A few anterior and posterior teeth on coxa three. Fourth coxa with several dorsal and lateral hair-tipped spines, visible from above. A larger dorsal apical spine also present, but fourth coxa not widened laterally. Trochanters with scattered hairs, with small spines on trochanters two to four, the largest on four. Distal portion of second to fourth femora with two apical spines. Remainder of legs smooth except for scattered hairs. Fourth femur straight. Tarsal segments: 6-12-6-6. Distitarsus of first tarsus with three segments, second with three. One paratype has but five segments in the fourth tarsus.

Palpus: trochanter, 0.5 mm. long; femur, 1.3; patella, 0.7; tibia, 0.9; and tarsus, 0.8. Total length, 4.2 mm.

Palpus armed retrolaterally as in figure 12. Prolaterally armed as follows: femur and patella without armature; tibia with four spine-tipped tubercles; tarsus with two.

Chelicera normal, smooth except for a few scattered hairs. A slight elevation on the proximal segment.

Body reddish brown, darker brown mottlings on the dorsum, particularly around the margin of the scute and the anterior margin of the cephalothorax. Appendages lighter.

TYPE LOCALITY: Female holotype and female paratype from El Tucuche, Trinidad, November 12, 1944 (R. H. Montgomery).

This species differs from *Cranellus balthazai* Roewer by being more spinose and in lacking the white dorsal pattern. Unfortunately only females were available for study, and in these there were definitely no paired spines on the second free tergite, but in one the median tubercles of the second free tergite were somewhat enlarged. Possibly male specimens would show definite paired spines.

Phareicranaus calcariferus (Simon)

Figures 13-14

Goniosoma calcariferum SIMON, 1879, Ann. Soc. Ent. Belgique, vol. 22, p. 232.

Phareicranaus calcariferus ROEWER, 1913, Arch. Naturgesch., vol. 79, sect. A, no. 5, p. 402, fig. 159; 1923, Die Weberknechte der Erde, p. 559, fig. 700.

MALE: Total length of body, 9.6 mm. Cephalothorax, 3.5 mm. Width of body at widest portion, 7.8 mm.

	I	II
Trochanter	0.9 mm.	1.1 mm.
Femur	5.9	14.4
Patella	1.6	2.2
Tibia	3.9	9.7
Metatarsus	7.1	11.0
Tarsus	3.0	9.7
Total	22.4 mm.	48.1 mm.

	III	IV
Trochanter	1.3 mm.	1.6 mm.
Femur	9.5	12.2
Patella	1.8	2.7
Tibia	5.2	7.1
Metatarsus	9.8	13.8
Tarsus	3.6	4.7
Total	31.2 mm.	42.1 mm.

Dorsum smooth, paired tubercles on the first area. Paired spines on the third. Paired spines on the second and third free tergites. First area with a median line. Eye tubercle smooth, with a pair of large spines. Anterior and lateral margins of the cephalothorax with several tubercles. A transverse row of tuberculations across each free tergite except in the median area. Venter and coxae with scattered hairs, a transverse row of tuberculations across each free sternite. Anal operculum with a few scattered hairs and several tubercles. First to third coxa each with a transverse row of tubercles; these are largest on the first. Fourth coxa not widened laterally, but with a strong apical spine, and ventrally with one large tubercle anterior to the stigmata.

Legs with scattered hairs and tuberculations on the trochanters, femora, and patellae; very small ones on the tibiae. These tuberculations are more or less arranged in rows and are largest on the fourth femur. Apical portion of fourth femur with larger tubercles and two large spines, one on the retrolateral margin, the other on the prolateral margin. Fourth tibia with a prolateral row of heavy spines. Femora of all legs straight. Tarsal segments: 8-20-9-11. Distitarsus of first tarsus with three segments, second with three.

Palpus: trochanter, 1.2 mm. long; femur, 3.2; tibia, 1.6; metatarsus, 1.8; and tarsus, 2.2. Total length, 10 mm. Palpus armed retrolaterally as in figure 14. Prolaterally armed as follows: femur with a dorsal apical spine, but no median apical spine, otherwise unarmed; patella unarmed; tibia with four spine-bearing tubercles; tarsus with four spine-bearing tubercles, the proximal one very small. Entire palpus clothed throughout with hairs.

Chelicera slightly enlarged, with scattered hairs and a few dorsal tuberculations.

Dorsum light reddish brown with a very dark brown pattern giving a netted appearance over the entire dorsum. Spines of the eye, third area, and free tergites light, a small strip of white on the lateral border of the scute, extending from the

first to the third area. A strip of white at the posterior margin of the fourth area, a small strip of white at the posterior margin of the first and second free tergites, a broad strip of white at the posterior margin of the third free tergite, the last free sternite also white. The dark anal operculum appears to be surrounded by a ring of white. Venter and coxae reddish brown, with dark brown fleckings. Appendages lighter, with much darker brown mottling particularly on the chelicera and palpi.

FEMALE: Total length of body, 9.6 mm. Cephalothorax, 3.6 mm. Width of body at widest portion, 7.8 mm.

Identical in appearance with male, but the large spines of the fourth femur and the ventral tubercles of the fourth coxa are missing.

RECORDS: Tucker Valley, near Navy Base, southwest Trinidad. November and December, 1944 (R. Ingle).

Rhopalocranaus albilineatus Roewer

Figures 19-20

Rhopalocranaus albilineatus ROEWER, 1932, Arch. Naturgesch., new ser., vol. 1, no. 2, p. 285, fig. 3.

MALE: Total length of body, 5.4 mm. Cephalothorax, 1.8 mm. Width of body at widest portion, 4.2 mm.

	I	II
Trochanter	0.6 mm.	0.7 mm.
Femur	3.2	7.6
Patella	1.0	1.5
Tibia	1.6	4.7
Metatarsus	2.3	5.1
Tarsus	3.2	5.2
Total	11.8 mm.	24.8 mm.
	III	IV
Trochanter	0.7 mm.	0.8 mm.
Femur	7.0	6.6
Patella	1.4	1.1
Tibia	2.4	3.3
Metatarsus	4.5	6.6
Tarsus	2.5	3.3
Total	18.5 mm.	21.7 mm.

Dorsum with four areas. First area with median paired spines, and a small tubercle laterad to each spine. No median line present. Second area without median

armature, but with a small tubercle on either side midway between the median line and the lateral margin. Third area with a pair of robust spines, small tubercles laterad to each of the spines. Fourth area and first free tergite smooth. Second and third free tergite with a pair of median tubercles. Eye tubercle with a small spine over each eye. Cephalothorax smooth, one or two small spines on either side at the anterior lateral margin. Anal operculum smooth except for scattered hairs, each free sternite with a transverse row of hairs and small granulations. Coxae with scattered hairs and tubercles, a transverse row of tubercles across the first coxa. Third coxa with a few anterior and posterior teeth. Several spinose tubercles on the fourth coxa, visible from above. Fourth coxa not widened laterally and with a dorsal apical spine.

Legs smooth. A few tubercles on the trochanters of the legs, remaining segments smooth except for scattered hairs. Tarsal segments: 6-15-7-7. Distitarsus of first tarsus with three segments, second with three. Basitarsus of first tarsus much enlarged.

Palpus: trochanter, 0.7 mm. long; femur, 1.6; patella, 0.9; tibia, 10; and tarsus, 0.8. Total length, 5 mm. Palpus armed retrolaterally as in figure 19. Pro-laterally armed as follows: femur and patella unarmed; tibia with five spine-bearing tubercles; tarsus with two spine-bearing tubercles.

Chelicera normal, with scattered hairs.

Dorsum reddish brown with white lines as in figure 20. Venter concolorous with the dorsum, legs lighter with darker brown mottlings. Chelicera and palpus yellowish.

RECORD: Tucker Valley, southwest Trinidad, November, 1944 (R. Ingle).

Heterostygninae Roewer

Pseudostygnoplus clavotibialis, new species

Figures 15, 16, 18

MALE: Total length of body, 4.4 mm. Cephalothorax, 3.7 mm. Width of body at widest portion, 2.1 mm.

	I	II
Trochanter	0.6 mm.	0.7 mm.
Femur	3.1	6.7
Patella	0.8	1.2
Tibia	1.8	4.8
Metatarsus	3.3	5.8
Tarsus	1.7	4.2
Total	11.3 mm.	23.4 mm.
	III	IV
Trochanter	0.8 mm.	0.8 mm.
Femur	4.8	6.3
Patella	1.3	1.4
Tibia	2.7	3.7
Metatarsus	4.8	7.0
Tarsus	2.1	2.2
Total	16.5 mm.	21.4 mm.

Dorsum with four areas, first area with median line. First area with median paired tubercles and with another tubercle on either side laterad to the median paired ones. Second area without median armature, but with three tubercles on either side. Third area with a pair of large acute diverging spines. In addition there are several small tubercles laterad and posterior to the median spines. Fourth area with only a few granulations, free tergites smooth except for scattered hairs. Cephalothorax without an eye tubercle, eyes widely separated and at the posterior portion of the cephalothorax. A median spine on the cephalothorax, arising from a mound. Anterior margin of cephalothorax with two small spines on either side. Anal operculum smooth except for scattered hairs. A row of very fine tubercles across each free sternite, coxae with scattered hairs, a few small tubercles present. First coxa with a transverse row of hair-tipped tubercles, third coxa with anterior and posterior rows of teeth.

Legs with scattered hairs. Trochanters except for the first with scattered tubercles which are enlarged into several spines on the fourth, including a very large dorsal one. A particularly prominent dorsal posterior spine present on the fourth coxa. Second to fourth femora with tubercles more or less arranged in rows, two distal dorsal spines on the second to fourth femora. Fourth femur with the tubercles enlarged, several actually spines at the distal retrolateral margin. These are arranged into two rows. Fourth patella with

several dorsal spines, two very prominent ventral ones. Fourth tibia clavate with several spines at the distal end. Patella and tibia of first to third legs clothed only with hairs. Tarsal segments: 7-19-7-8. Distitarsus of first tarsus with three segments, second with three. A few specimens had only six segments in the first tarsus. Scopula present on the third and fourth tarsi; tarsal claws toothed.

Palpus: trochanter, 0.7 mm. long; femur, 3.3; tibia, 1.8; metatarsus, 1.8; and tarsus, 1.6. Total length, 9.2 mm. Palpus elongate. Armed retrolaterally as in figure 18. Prolaterally: femur and patella unarmed; tibia with armature the same as on the retrolateral margin; tarsus with armature the same as on the retrolateral margin.

Chelicera with scattered hairs. Second segment considerably enlarged. A few tubercles on the proximal segment.

Entire body reddish brown, with mottlings on the cephalothorax, giving a netted appearance of lighter punctations. Appendages except for femur, patella, and tibia of fourth leg lighter than the body, with brown mottlings. Fourth leg with

segments the same color as the body. A pencilling of white at the posterior lateral margin of the dorsal scute. This is lacking in some specimens.

FEMALE: Total length of body, 4.5 mm. Cephalothorax, 2.1 mm. Width of body at widest portion, 3.9 mm.

Similar in appearance to male, but with reduced chelicera. Also lacking the heavy spination of the fourth leg.

TYPE LOCALITY: Male holotype and male and female paratypes from Tucker Valley, southwest Trinidad, November, 1944 (R. Ingle). Additional paratypes from Sangre Grande, Trinidad, December, 1944 (R. H. Montgomery) and from Caparo, Trinidad, March 15, 1910 (P. B. Whelpley).

This species is related to *P. longipalpus* Goodnight and Goodnight, differing in the spination of the fourth leg. It lacks the single large spine on the tibia. (See fig. 17.)

The animal listed as *Pseudostygnoplus longipalpus* Goodnight and Goodnight (1942, Amer. Mus. Novitates, no. 1234, p. 13) actually was this new species.

SUBORDER PALPATORES THORELL

Tribe Eupnoi Hansen and Soerensen

PHALANGIDAE Simon

Gagrellinae Thorell

Prionostemma vittatum Roewer

Figure 9

Prionostemma vittatum ROEWER, 1910, Abhandl. Ver. Hamburg, vol. 19, no. 4, p. 186, pl. 2, fig. 27, pl. 3, figs. 18-19; 1923, Die Weberknechte der Erde, p. 1085, fig. 1204.

MALE: Total length of body, 3.4 mm. Cephalothorax, 1.1 mm. Width of body at widest portion, 2.2 mm. Length of femora: I, 9.7 mm.; II, 15.7 mm.; III, 10.5 mm.; IV, 11.7 mm.

Dorsum with numerous small depressions giving a netted appearance. Eye tubercle at the posterior portion of the cephalothorax, canaliculate, with a row of sharp spines over each carina. Supracheliceral lamella prolonged into two obtuse spines. Free sternites each with a transverse row of small tubercles and with

scattered hairs. Coxae and genital operculum with scattered tuberculations. Three pronged teeth on the anterior and posterior margins of each coxa.

Legs with scattered hairs, rows of small spines present on the femora, patellae, and a few on the tibiae. Nodules: 0-3-0-1.

Palpus: trochanter, 0.2 mm. long; femur, 1.0; patella, 0.5; tibia, 0.7; and tarsus, 1.2. Total length, 3.6 mm. Palpus with scattered hairs on all segments. Femur armed ventrally with spines. Patella and tibia covered with spines; patella with an inner apophysis which is likewise armed with spines.

Body golden, eye tubercle dark brown to black, a dark spot on the cephalothorax at the base of the eye tubercle. In some specimens there is more brown mottling, present on the abdomen. Trochanters, bases of femora dark brown, contrasting strongly with the coxae. Remainder of

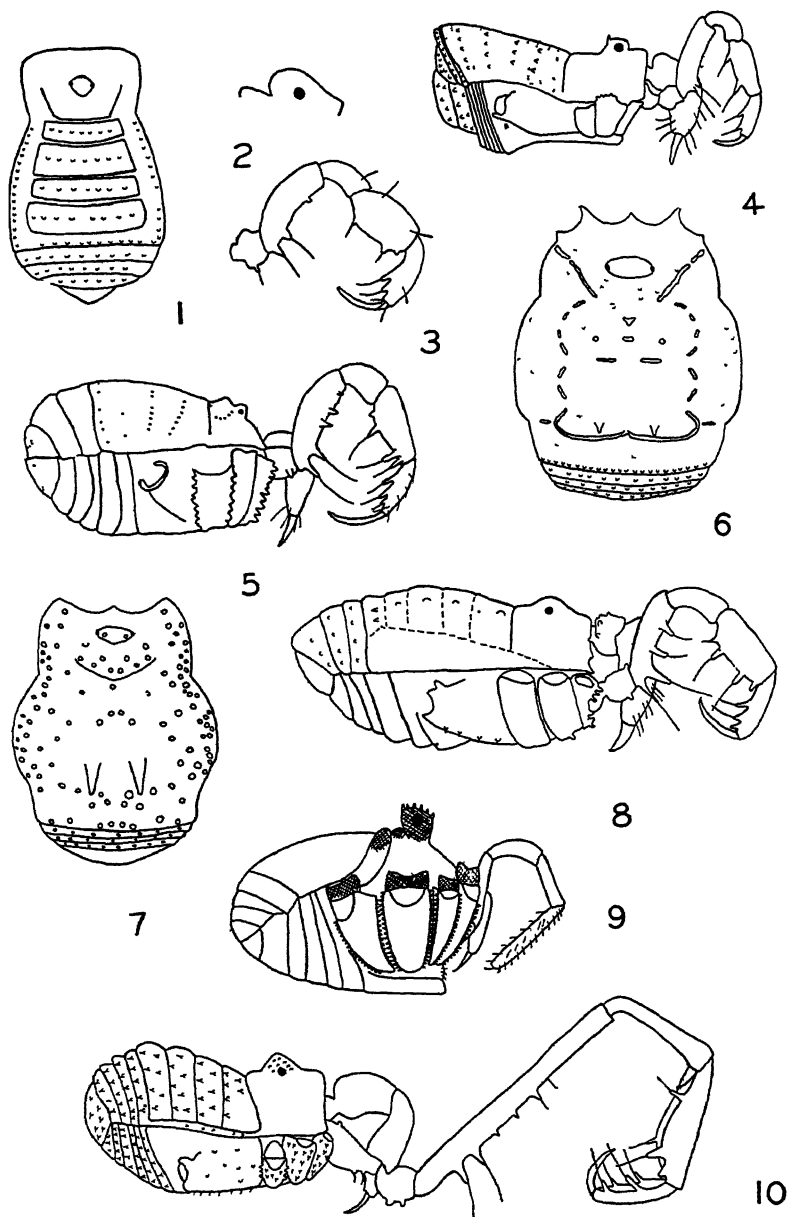
legs brownish. Chelicera and palpus light yellow.

FEMALE: Total length of body, 3.9 mm. Cephalothorax, 1.6 mm. Width of body at widest portion, 2.9 mm. Length of fem-

ora: I, 8.4 mm.; II, 13.6 mm.; III, 9.9 mm.; IV, 9.2 mm.

Similar in appearance to male.

RECORDS: Tucker Valley, southwest Trinidad, November, 1944 (R. Ingle); Port-of-Spain, Trinidad, July 4, 1926.



- Fig. 1. *Pellobunus trispinatus*, new species, dorsal view of male.
 Fig. 2. Idem, lateral view of eye tubercle of male.
 Fig. 3. Idem, retrolateral view of palpus of male.
 Fig. 4. *Kalina tuberculata*, new species, lateral view of holotype.
 Fig. 5. *Vima albiornata*, new species, lateral view of holotype.
 Fig. 6. *Cymortula granulata* Roewer, dorsal view of male.
 Fig. 7. *Paecilaema inglesi*, new species, dorsal view of male.
 Fig. 8. *Trinella intermedia*, new species, lateral view of holotype.
 Fig. 9. *Prionostemma vittatum* Roewer, lateral view of male.
 Fig. 10. *Pellobunus longipalpus*, new species, lateral view of holotype.

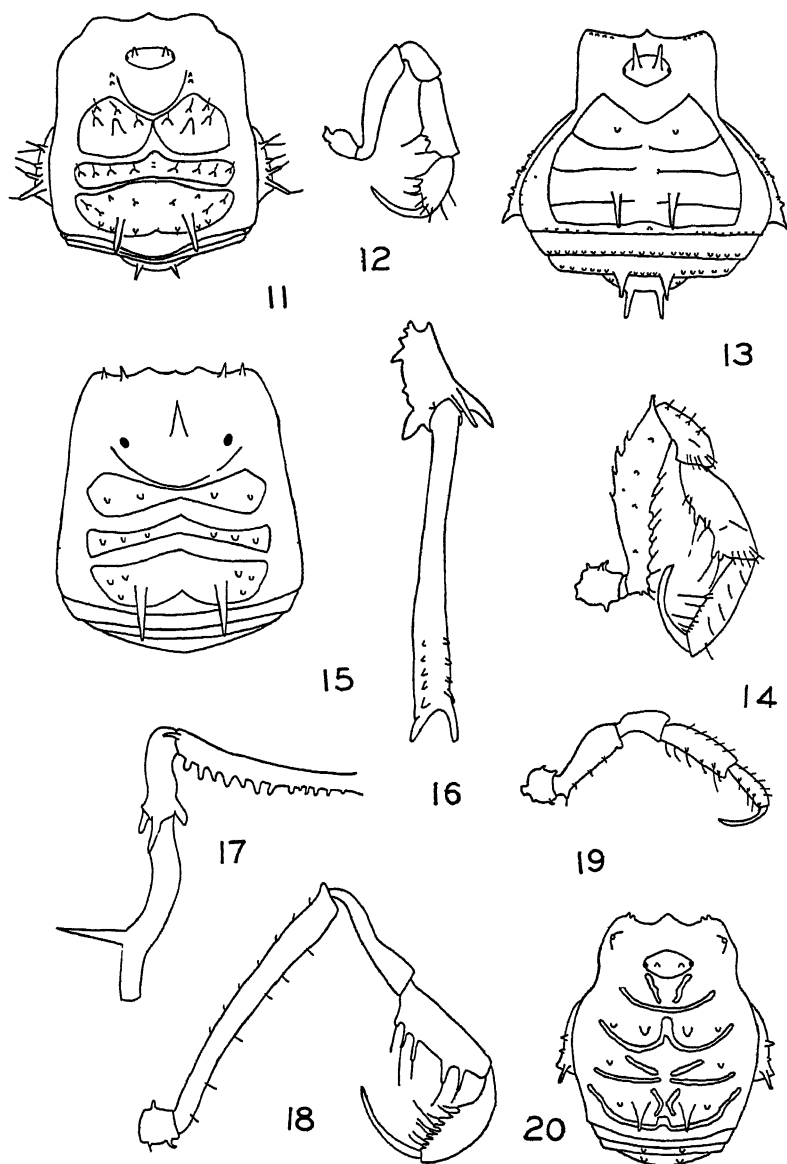


Fig. 11. *Cranellus montgomeryi*, new species, dorsal view of female.

Fig. 12. Idem, retrolateral view of palpus of female.

Fig. 13. *Phareicranus calcariferus* (Simon) dorsal view of male.

Fig. 14. Idem, retrolateral view of palpus of male.

Fig. 15. *Pseudostygnoplus clavotibialis*, new species, dorsal view of male.

Fig. 16. Idem, ventral view of patella and tibia of fourth leg of male.

Fig. 17. *Pseudostygnoplus longipalpus* Goodnight and Goodnight, dorsal view of femur, patella, and tibia of fourth leg of male.

Fig. 18. *Pseudostygnoplus clavotibialis*, new species, retrolateral view of palpus of male.

Fig. 19. *Rhopalocranus abritineatus* Roewer, retrolateral view of palpus of male.

Fig. 20. Idem, dorsal view of male.

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THE STATUS OF THE GENUS *LEPTODRYMUS* AMARAL, WITH COMMENTS ON MODIFICATIONS OF COLUBRID PREMAXILLAE

BY C. M. BOGERT

The classification of the Central American colubrid currently known as *Salvadora pulcherrima* (Cope) has been troublesome to taxonomists since its earliest description. Originally described by Cope in 1874 as *Masticophis pulcherrimus* the species has been inadvertently redescribed twice under different generic names and referred to two additional genera. Further confusion has resulted from superficial resemblances of this Central American species with *Salvadora lemniscata* of the Pacific slope in the Tehuantepec region of Mexico; Bocourt (1890), as well as Boulenger (1893) and some recent authors, uses the name *pulcherrimus* for the latter, apparently without having seen the smaller snake to which the name is properly applied. I attempted to clarify the situation in 1939b and placed some of these erroneous citations in the synonymy of *Salvadora lemniscata*. Other references are assigned in the synonymy below.

Although relatively few additional specimens of *pulcherrimus* have come to hand, it is now possible to re-evaluate the status of the form in the light of additional data drawn from other genera. Stuart (1932) was the first to suggest that the species belonged in the genus *Salvadora*, although he presented no data to substantiate the putative relationship. Cope (1887) had placed the species in the genus *Drymobius*, but inasmuch as he included a variety of other species in the group the implications of the action are dubious. Amaral (1927), unaware of the identity of his type specimen with those described by Cope and by Boettger, erected the genus *Leptodrymus* and called the species *clarki*. Amaral asserted that *Leptodrymus* was related to both *Dry-*

mobius Fitzinger and "*Leptophis* Wagler" (now *Thalerophis* Oliver, 1947). Dunn (1931), who pointed out the synonymy of the three specific names, suggested that *Leptodrymus* might be a valid genus. In this view I concur. It is difficult to ascertain which group of colubrids it most closely resembles, although the premaxilla is virtually identical with that of some species of *Thalerophis*. However, the hemipenis differs from that of other American colubrids, and there appear to be scale characters that leave *pulcherrimus* unacceptable in currently recognized genera to which it supposedly might be allied.

Because the species cannot be placed in any group with certainty, the monotypic genus *Leptodrymus* must be recognized; there appears to be no alternative at present, although it is hoped that additional studies of Neotropical colubrids will clarify the relationships of the genera and permit a more satisfactory arrangement of the groups. There would be no objection to the inclusion of *pulcherrimus* in the genus *Salvadora* (even though the range of variation in generic characters would have to be extended to do so), but for the fact that *pulcherrimus* seems to be more closely allied to *Thalerophis*, *Dendrophidion*, *Dryadophis*, and perhaps to other Neotropical colubrids.

Although the genus was diagnosed by Amaral (1927), he failed to include all vacant sockets in his count of the maxillary teeth, the hemipenis is erroneously depicted, and other characters that prove to be of diagnostic significance were omitted. The genus may be redefined with additional characters included, and a summary of variations within the species can be added

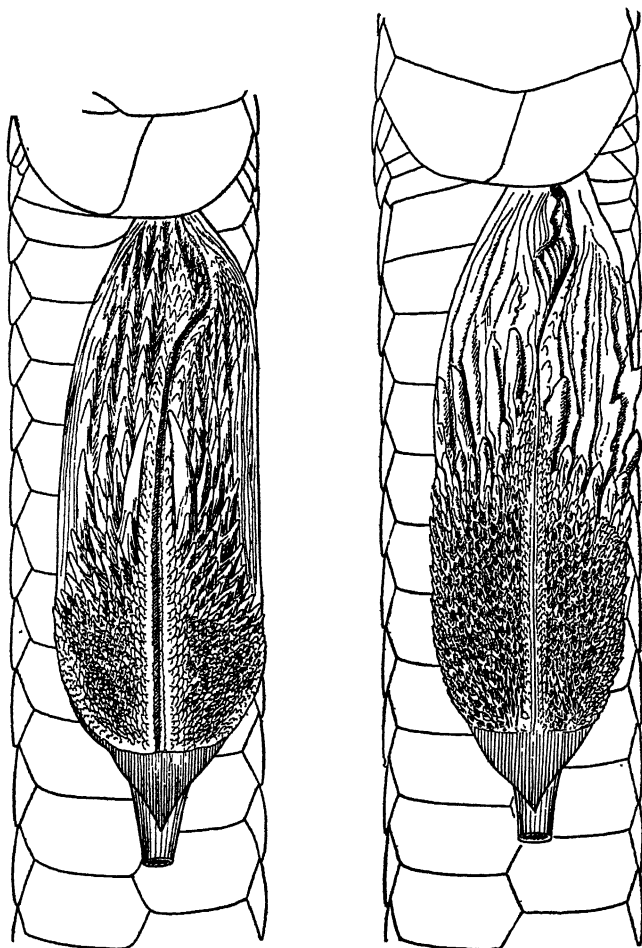
**LEPTODRYMUS PULCHERRIMUS****SALVADORA LEMNISCATA**

Fig. 1. Left hemipenes of *Leptodrymus pulcherrimus* (M.C.Z. No. 38737, enlarged $\times 4$) and *Salvadora lemniscata* (U.S.N.M. No. 109245, enlarged $\times 2$), depicted as dissected from the retracted position, slit down the dorsum and spread out on the under surface of the tail. Note the symmetrical arrangement of the spines in *pulcherrimus* in contrast to the asymmetrical condition in *lemniscata*, with only one greatly enlarged spine adjacent to the sulcus.

that will supplement the description previously given (Bogert, 1939a, p. 184).

LEPTODRYMUS AMARAL

Leptodrymus AMARAL, 1927, Bull. Antivenin Inst. Amer., vol. 1, p. 29. Genotype *clarki* = *pulcherrimus*.

DEFINITION: A genus of colubrid snakes with the following characters: Hemipenis with basal spines and distal calyces in symmetrical arrangement flank-

ing an undivided sulcus, one strongly enlarged spine on each side of the sulcus near the middle of the organ (fig. 1). Premaxilla with pronounced lateral projections not strongly recurved (fig. 2). Maxilla (fig. 4) with 17 to 19 subequal teeth followed after a diastema by three enlarged teeth; mandibular teeth 19 to 21. Dorsal scales smooth, with double apical pits, arranged in 17 rows at midbody but reducing to 15 at the base of the tail by sup-

pression of the fourth row in the region of the body between 124th and 136th ventral. Rostral normal, width greater than height. Loreal twice as long as broad. One preocular and three postoculars, strongly pitted, the pitted area extending forward to the loreal, onto the upper portion of the supralabials and posteriorly onto the anterior temporals. (Depending on the manner of preservation these structures, possibly tactile organs, appear as tiny pustules or as pits. On removed epidermal coverings of the scales they appear as holes or transparent dots.)

Leptodrymus pulcherrimus (Cope)

1874. *Masticophis pulcherrimus* COPE, Proc. Acad. Nat. Sci. Philadelphia, vol. 26, p. 65. (Type locality, "Western side of Central America"; cotypes, Academy of Natural Sciences of Philadelphia Nos. 14688 and 5199.)
1887. *Drymobius pulcherrimus* COPE, Bull. U. S. Natl. Mus., no. 32, p. 70.
1894. *Zamenis pulcherrimus*, GÜNTHER (partim), Biologia Centrali-Americana, Reptilia and Batrachia, p. 123.
1898. *Zamenis bitaeniatus* BOETTGER, Katalog Reptilian-Sammlung in Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, pt. 2, p. 42, footnote. (Type locality, Retalhuleu, Guatemala.)
1927. *Leptodrymus clarki* AMARAL, Bull. Antivenin Inst. Amer., vol. 1, no. 1, p. 29. (Type locality, Tela, Honduras; type, Museum of Comparative Zoölogy No. 20207.) 1929, Mem. Inst. Butantan, São Paulo, vol. 4, p. 160.
1929. *Masticophis bitaeniatus*, AMARAL, Mem. Inst. Butantan, São Paulo, vol. 4, p. 153.
1931. *Leptodrymus pulcherrimus*, DUNN, Copeia, p. 163. STUART, 1933, Copeia, p. 9.
1933. *Salvadora pulcherrimus*, STUART, Copeia, p. 10.
1939. *Salvadora pulcherrima*, BOGERT, Publ. Univ. California at Los Angeles in Biol. Sci., vol. 1, p. 182, pl. 3.
1943. *Salvadora pulchra*, SCHMIDT, Amer. Midland Nat., vol. 30, p. 252.

MATERIAL EXAMINED: Three females and seven males, including M.C.Z. No. 20207, Toloa Creek, Tela, Honduras (type of *clarki*); M.C.Z. No. 38737, Portillo Grande (=El Portillo?), 4100 feet elevation, Honduras; U.S.N.M. Nos. 79965, 79966, Managua, Nicaragua; U.S.N.M. No. 16127, "Nicaragua?"; A.N.S.P. Nos. 5199, 14688, "Western side of Central America," probably Nicaragua (cotypes of *pulcherrimus*); U.S.N.M.

No. 38150, Pacaca, Costa Rica; A.N.S.P. No. 22623, Tileran, Costa Rica; and U.S.N.M. No. 25239, no locality data. The only additional specimen reliably reported is the type of *Zamenis bitaeniatus* taken at the northern extremity of the known range near Retalhuleu, Guatemala.

SUMMARY OF CHARACTERS: Head shields as depicted in figure 5, with minor variations; the supralabials are uniformly nine except on the female from Managua, which has 10 on the left side with the second, third, and fourth reaching the loreal instead of the normal second and third. The infralabials are normally 10 (rarely 12) with the first five in contact with the anterior chin-shields. The preocular is uniformly single, and all specimens examined have three postoculars, although the type of *Z. bitaeniatus* reportedly had but two. The temporals normally are 2+2+2, but any pair is occasionally single, with other modifications such as those seen on the snake depicted in figure 5. Conspicuous pits or pustules are present on the preocular, postoculars, and the adjacent scales.

The ventrals range from 195 to 205 in males, mean 200.8, and from 204 to 210, mean 208, in females. The anal plate is divided. The subcaudals are in two series, ranging from 145 to 152 in males, and from 148 to 152 in females (for three of each sex having complete tails). The dorsal scales are disposed in 19 rows on the neck, 17 at midbody, and 15 at the base of the tail. The reduction from 19 to 17 rows on the neck results from suppression of the fourth row in the region above the seventh to eleventh ventrals. The midbody reduction results from the loss of what has become the fourth row in the region between the 124th and 136th vertebrae in males, and between the 134th and 140th in females. An average difference between the sexes is indicated; the mean number for the vertebra where suppression takes place is 131 in males and 137 in females.

FORM: The body is relatively slender, with the head distinct from the neck. The eye is large, with a diameter equal to approximately three times the height of the fifth supralabial. The ratio of the tail to

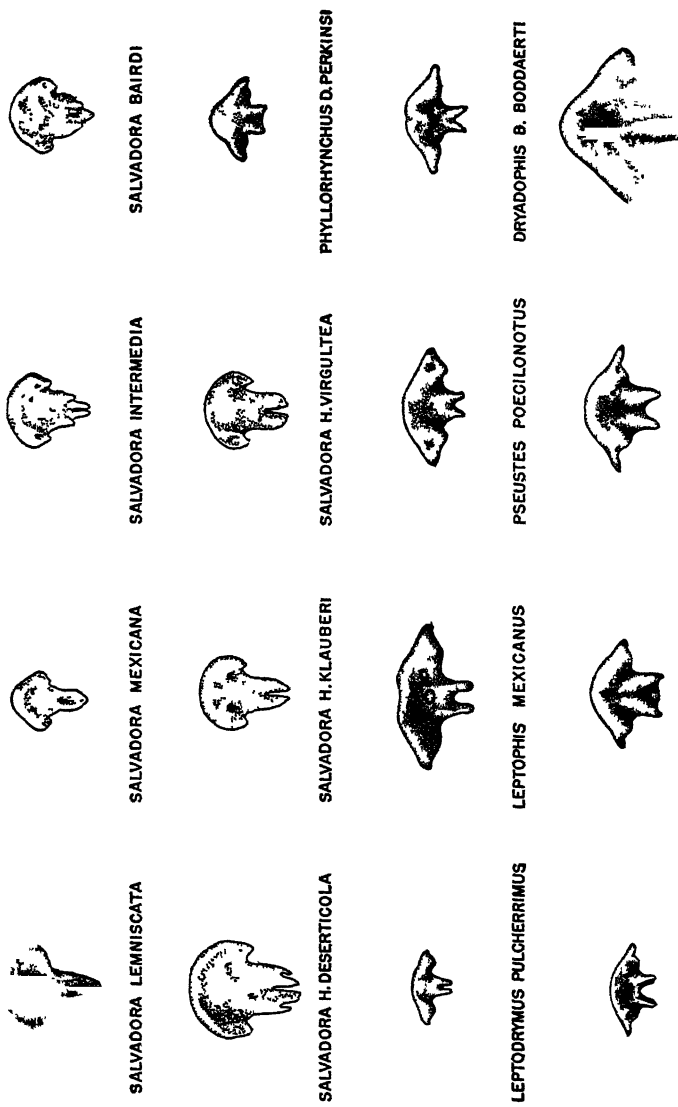


Fig. 2. Ventral views of the premaxillae of representative species of *Salvadora* and other American colubrids (enlarged from $\times 2.5$ to $\times 5$), to show similarities of the bone in representatives of a single genus, and the differences between these premaxillae and the same cranial element in other snakes. Those of *Leptodrymus pulcherrimus* and *Leptophis* (= *Thaderophis*) *mericanus* are essentially similar, and obviously different from those of *Salvadora*, to which *pulcherrimus* has been assigned.

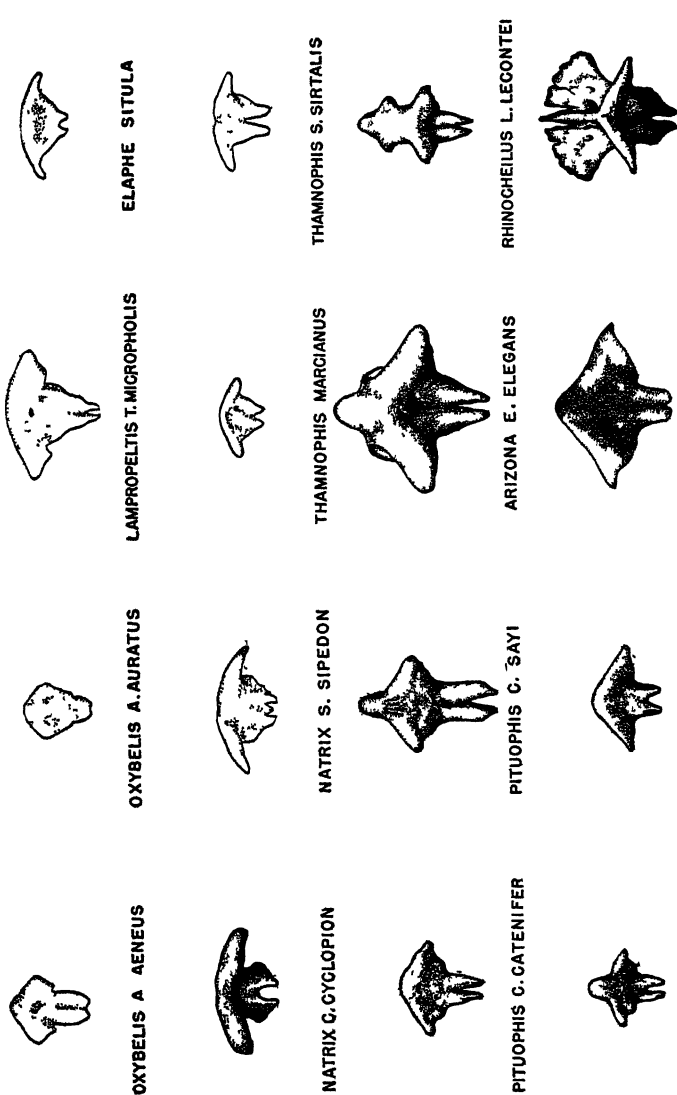
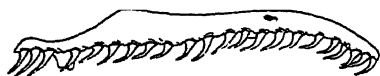


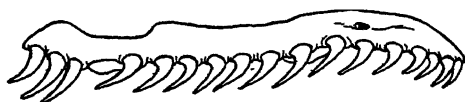
Fig. 3. Ventral views of the premaxillae (enlarged $\times 2.5$ to $\times 5$) of miscellaneous colubrids, including representatives of the subfamilies Natricinae, Xenodontinae, and Colubrinae, including such specialized forms as *Oxybelis* and *Heterodon*. The monotypic genera *Arizona* and *Rhinocheilus*, representing fossorial species, are similar in possessing the projection at the anterior of the bone, a condition approached in *Pituophis*, as well as in the Asiatic *Coluber spinalis*. See text for discussion of parallel modifications.

total length varies from .35 to .36 in males and from .33 to .36 in females. The largest specimen examined is a male (M.C.Z. No. 38737, from Portillo Grande = El Portillo?, Honduras) with an over-all length of 975 mm.

The maxillary contains from 17 to 19 subequal teeth followed after a diastema by three slightly enlarged teeth (fig. 4). Complete tooth counts for one specimen disclose 17+3 on the maxillary, 14 on the



LEPTODRYMUS PULCHERRIMUS



SALVADORA LEMNISCATA

Fig. 4. Lateral view of the right maxilla ($\times 8$) of the slender bodied *Leptodrymus pulcherrimus* compared with the same bone ($\times 5$) from *Salvadora lemniscata*, a larger, stouter species.

palatine, 30 on the pterygoid, and 21 on the dentary. The premaxilla has pronounced lateral projections that are feebly recurved posteriorly (fig. 2).

The hemipenis, as dissected in a preserved specimen, is noncapitate and not bifurcate distally, with a simple sulcus. Basal portion with small spines in about 10 rows; near the middle larger spines are arranged in four rows on either side of the sulcus, with the larger spines flanking the sulcus; two greatly enlarged spines are inserted at the level of the sixth subcaudal. Distally the spines diminish in size and merge with strongly denticulate calyces on the terminus. At the middle an area of longitudinal ridges without spines or calyces lies beyond the outer row of spines. (See fig. 1.)

PATTERN: Dorsum of head greenish. Belly and lips immaculate cream color. Body with middorsal light stripe occupying the median scale row and half of each ad-

jacent scale row, flanked on each side by a black stripe that covers two scale rows and half of each adjacent row (fig. 6). The black stripes extend onto the tail, diminishing in width in proportion to the diameter of the appendage. Anteriorly the stripes extend on the neck and across the temporals to the eye (fig. 5). On some specimens there is a vestige of the stripe on the loreal region in front of the eye.

RANGE: Central America, from approximately 10° N. in Costa Rica, northward to Tela on the Atlantic coast of Honduras, and westward to Retalhuleu in southwestern Guatemala near the Pacific coast. Nothing is recorded concerning the habitat, although the species has a vertical distribution from near sea level to at least 4100 feet elevation.

RELATIONSHIPS: In making comparisons data have been drawn from the papers by Stuart (1932 and 1941), who supplies summaries of characters for the genera *Dryadophis*, *Dendrophidion*, *Drymobius*, and *Drymoluber*. The data for *Masticophis* and *Coluber* are taken from Ortenburger (1928). Summaries of variation for the genus *Thalerophis* (= *Leptophis* auct.) have been generously supplied by my colleague, Dr. James A. Oliver, and those for the genus *Salvadora* have been drawn from my own unpublished data. These genera contain the species that most closely resemble *pulcherrimus*, but the combination of characters found in the latter differs from that of any other group.

First it should be pointed out that *Leptodrymus* differs from these other genera in the structure of the hemipenis. No other group contains species with enlarged basal spines in symmetrical arrangement on the copulatory organ (cf. those in fig. 1). Either basal spines are entirely lacking, or there is one greatly enlarged spine on only one side of the sulcus. In some groups, namely, *Coluber* and *Thalerophis*, the enlarged basal spines may be present or absent, but when present these spines are restricted to one side. *Leptodrymus* seems to be similarly unique in normally having three postoculars. Three scales behind the eye occur in related genera only as an abnormality. Aside

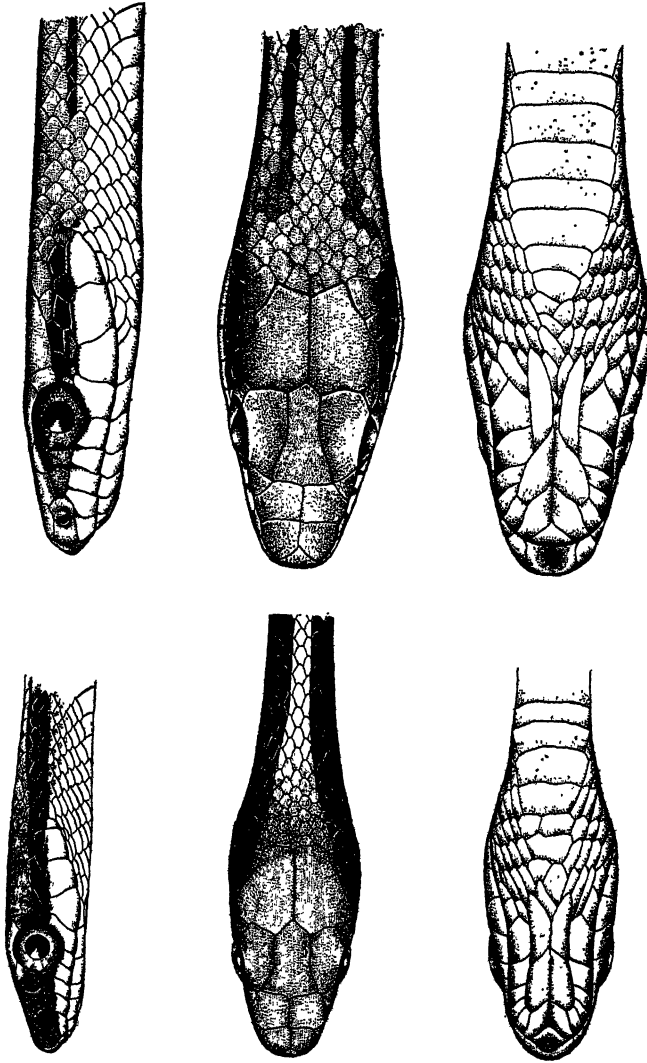
**LEPTODRYMUS PULCHERRIMUS****SALVADORA LEMNISCATA**

Fig. 5. Lateral, dorsal, and ventral views of the heads of adult *Leptodrymus pulcherrimus* and sub-juvenile *Salvadora lemniscata*, to show differences in habitus, scalation, and pattern.

from these characters, the principal differences between *Leptodrymus* and related American colubrid genera can be summarized, taking the various groups one by one, as follows:

1. *Salvadora*: Despite the confusion that existed with reference to *Salvadora lemniscata* and *L. pulcherrimus* the only close resemblance lies in the numbers of ventrals, caudals, and the number of midbody scale rows. The means for the ventrals and caudals are not identical, however; when only those specimens with complete tails are compared it is evident that the mean number of caudals in *pulcherrimus* closely approaches the maximum for *lemniscata*. In all but one species of *Salvadora* there is a reduction in the number of scale rows to 13 at the vent (in *S. g. lineata* 15 scale rows at the vent occur principally in females, less commonly in males), whereas in *pulcherrimus* all specimens available retain 15 scale rows at the vent. The loreal plate in *pulcherrimus* is normally twice as long as high, the upper edge roughly parallel with the lower; in *Salvadora* the loreal is divided in some species, but when single it is more commonly subtriangular, never twice as long as high. The eye in *pulcherrimus* is proportionately larger than it is in *Salvadora*, with a diameter three times as great as that of the fifth labial; the supralabials in *Salvadora* are not so flat as they are in *pulcherrimus*, and the diameter of the eye is only twice that of the fifth labial. The conspicuous pits or pustules on the scales around the eye of *pulcherrimus* are absent in *Salvadora*.

The habitus of *Salvadora* resembles that of the racers, particularly *Masticophis*, but *Leptodrymus* is a relatively more slender snake, with a mean tail/total length slightly exceeding the average for either of the latter. The slender body and large eye suggest that *pulcherrimus* is primarily an arboreal snake, although this supposition remains to be verified; all *Salvadora* appear to be rather strictly terrestrial.

As may be seen in figure 2, the shape of the premaxilla in *Salvadora* characterizes the snakes in the genus, although the bone in *lemniscata* and *mexicana* differs some-

what from that in the *grahamiae* group, which includes the other species. The lateral projections are greatly reduced and the front of the bone is convex in all *Salvadora*, whereas in *Leptodrymus* the shape of the premaxilla (fig. 2, third row) approximates that of other colubrids. No skull of *pulcherrimus* has been available for detailed comparisons of cranial elements, but there is no species of *Salvadora* with so many maxillary or pterygoid teeth.

Leptodrymus, as well as all *Salvadora*, possesses patterns consisting of a light vertebral stripe flanked by darker stripes. But on all *Salvadora* save *grahamiae* there

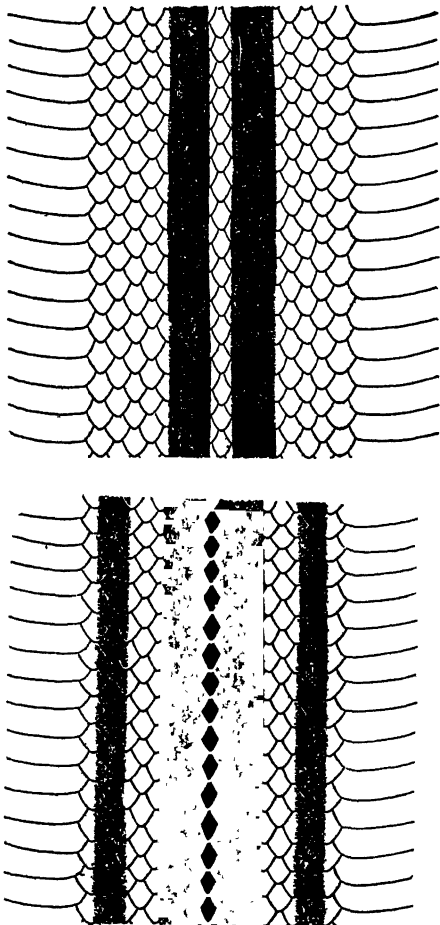


Fig. 6. Midbody patterns of *Leptodrymus pulcherrimus* (upper) and *Salvadora lemniscata* (lower).

are pronounced lateral stripes (cf. drawings in fig. 6), and in the latter the vertebral is three scales wide. Although the pattern fades in preservative to clay white, the middorsal stripe of *pulcherrimus* is reported to be reddish or yellowish in life; anteriorly it is emerald green, this brilliant color extending over the entire top of the head, according to Cope. These colors are unknown in *Salvadora*. Aside from superficial resemblances in pattern, as seen on the preserved snake, *pulcherrimus* has few characters of importance that point to close affinity with the patchnosed snakes in *Salvadora*.

2. *Thalerophis*: The snakes of this genus (long known as *Leptophis*) have not been critically studied until recently. The genus includes a number of species that are characterized by having the dorsal scale formula 15-15-11, some of the dorsal scales with keels, various patterns, most of them either green or comprised of darker longitudinal stripes, invariably involving some green coloration. The green coloration of *Leptodrymus* is not greatly different from that seen on freshly preserved *Thalerophis diplotropis*, for example, a species with a light vertebral stripe flanked by black stripes at the anterior of the body. Snakes of the genus *Thalerophis* more closely approximate *pulcherrimus* in the shape and contours of the head, with the relatively large eye, and the flattened loreal, when this plate is present. The premaxillae of the snakes in the two genera are nearly identical, and they share in common the pitted scales on each side of the eye.

Aside from the differences in the scale reduction formulas and dorsal scales, keeled in *Thalerophis* and smooth in *Leptodrymus*, Dr. Oliver has pointed out to me that in the former two labials reach the eye, and there is but one anterior temporal. While variation in the number of maxillary teeth could include the condition found in *pulcherrimus*, there is no diastema present in snakes of the genus *Thalerophis*. In addition, the relative tail length of *Thalerophis* is greater, there are invariably more caudals, and there is ordinarily no more than one apical scale pit posterior to the point of dorsal scale reduction, whereas in *Leptodrymus*

there are two pits on scales throughout the length of the body.

3. *Drymoluber*: This genus erected by Amaral in 1929 contains but two species, both of them confined to South America. Aside from the gap in the range that would exist if *pulcherrimus* were added to the genus, *Drymoluber* possesses but eight supralabials, and fewer ventrals, fewer caudals, and tails that comprise approximately one-fourth of the total length. In pattern characters there is no resemblance whatsoever to *Leptodrymus*. The body is not so slender as it is in the latter, although the pits on the preoculars and postoculars are present. There is no diastema in the maxillary dentition.

4. *Drymobius*: Four species comprise this genus; all have keeled dorsal scales, and relatively low ventral counts (with a maximum of 170 according to Stuart, 1933). Pits are present on preoculars and postoculars. None of the species possesses a pattern of longitudinal stripes. The maxillary teeth are reported by Stuart to vary from 22 to 34, enlarged posteriorly, although a diastema is lacking. The premaxilla has rather narrow lateral projections (at least in *margaritiferus*), but the shape of the bone suggests that *Drymobius* is not distantly related to *Leptodrymus*. The body is not so slender, however, and the characters of the hemipenis, of the pattern, the keeled dorsal scales, and the presence of but two postoculars, as well as the relatively smaller eye, suggest that the relationship is not close.

5. *Dryadophis*: Snakes of this genus, particularly those in the *boddaerti* group as defined by Stuart (1941), exhibit variations in the normal scalation of species that might include *L. pulcherrimus* except for the presence of only two postoculars. *Dryadophis* contains species with patterns of blotches or stripes, but there is no pattern that closely approaches that of *pulcherrimus*. *Dryadophis* includes species with proportionately shorter tails, and the body is not so slender as it is in *pulcherrimus*. Although the maxillary dentition includes the variations found in *Leptodrymus*, the shape of the premaxilla is modified along somewhat different lines. On the whole, *Leptodrymus* appears to be

about as closely related to *Dryadophis* as it is to *Thalerophis*.

6. *Dendrophidion*: Some species of *Dendrophidion* possess striped patterns not dissimilar from those of *Leptodrymus*, but the keeled scales of the former, the extraordinarily great number of maxillary teeth (33 to 50 according to Stuart), and the differences in the shape of premaxilla do not point to close relationships.

7. *Coluber*: The snakes of this genus, which includes only two species, possess relatively few characters in common with *Leptodrymus*. For *Coluber* Ortenburger (*supra cit.*) reports 16 maxillary teeth as the maximum, and normally there are only seven supralabials. The premaxilla of *Coluber* more nearly resembles that of European racers (which probably can be referred to the genus *Zamenis*) than it does that of *Leptodrymus*, and probably the American species of *Coluber* are as closely related to Old World species as to *Leptodrymus*.

8. *Masticophis*: Recognized by some authors (or placed as a synonym of *Coluber*), this genus differs from *Leptodrymus* in more respects than it differs from the snakes referred to *Coluber*. *Masticophis* and *Salvadora* appear to be the only genera that lack the pits or pustules on the preocular, postocular, and anterior temporals, and the genera have many other features shared by *Salvadora lemniscata* and *S. mexicana*. The dentition is similar, and were it not for the modifications of the rostral and premaxilla, nine supralabials, and slight pattern differences, these two species of *Salvadora* might easily be referred to *Masticophis*, since the hemipenes are virtually identical. Consequently most of the characters that serve to differentiate *Leptodrymus* from *Salvadora* will serve as well to separate it from *Masticophis*.

DISCUSSION: On the basis of this brief review the conclusion may be drawn that *Leptodrymus*, despite its monotypic status, warrants recognition. It cannot be stated with assurance that the single species should be inserted in one or the other of the related genera in preference to another. At the same time it may be observed that it is questionable whether or not we are

dealing with characters of generic importance. It would be superfluous to point out that species have evolved along different lines, perhaps losing ancestral characters or acquiring new ones. Because we do not know, and are unlikely to learn, precisely what characters the ancestral colubrid had, we can do no more than guess whether some characters represent the primitive (or a specialized) condition. The inferences that can be drawn are often obscured by parallel modifications, and it is reasonable to suppose that evolution has been more rapid in some lines than in others. The infrageneric groups in some of the genera currently recognized differ from one another as much as other "full genera" differ. From some standpoints it would be preferable to place the eight New World genera (and perhaps others) in a single genus (*Coluber*), recognizing subgenera as well as species groups.

The state of our knowledge at present does not permit us to set up a phylogenetic arrangement that is very meaningful. The keys that have been constructed are largely artificial even though they serve the useful and practical purpose of simplifying the identification of specimens. In view of the fact that the same structure may be retained in one branch but strongly modified in another branch of the same general stock, it is inevitable that keys very often do not reflect phylogenies. *Salvadora*, *Masticophis*, and most species and subspecies of *Coluber* have similar hemipenes with enlarged basal spines, but one subspecies (*priapus*) of *Coluber constrictor* possesses a copulatory organ without enlarged spines. In this instance a difference exists between subspecies, virtually identical in other characters, that has been widely used as one of generic importance. It is possible, of course, to set up generic classifications on the basis of one character, as Inger and Clark (1943) have done. But the significance of such classifications is open to considerable doubt. On the other hand, a consideration of several characters seems often to complicate the picture to such an extent that conclusions become increasingly difficult.

Because of similarities in scale row reductions (to which they might have added

penial characters) Inger and Clark propose placing the Asiatic species *spinalis* in the genus *Coluber*. Had they examined the maxillary dentition it would have seemed obvious that the snake belonged in the same group as the European snakes they separated as *Zamenis*. Or if they had been basing their conclusions on pattern and coloration they might have felt impelled to lump the form with *Salvadora*. On the other hand, if they had examined the premaxilla (fig. 3) they could easily have shown that the snake was unique in this respect, and a new generic name might have been proposed.

The basic difficulty, of course, lies in

knowing which characters in any species can be given the most weight in setting up a natural classification. Generic names should be used to indicate similarities, but the choice of characters to do this is left to the judgment of the systematist. If he examines only one or two characters per species he is less likely to arrive at sound conclusions than he will if he considers several characters and selects those that seem to be of greatest importance. Analysis must precede synthesis, and however complex the situation may become, there is every likelihood that some useful knowledge will accrue if as many characters as possible are investigated.

PREMAXILLARY MODIFICATIONS

In the survey summarized above attention was directed to the characters of the premaxilla. Little use has been made of such characters in the past, although this element of the skull can profitably be used in defining genera or in working out phylogenies. In this instance I have been concerned primarily with the status of a species that has been assigned to the genus *Salvadora*, a group of snakes that includes species with various degrees of enlargement in the rostral plate. It was of interest, therefore, to ascertain whether osteological modifications accompanied those on the exterior of the snout. To accomplish this purpose it was necessary to examine, not only the premaxilla of all species of *Salvadora* (as well as the species *pulcherrima*, now referred to *Leptodrymus*), but representatives of related genera as well. Because the value of such a study could be enhanced by broadening it beyond the original scope of this note, the project was extended to cover species in other genera. The premaxillae of several colubrids have been depicted in figures 2 and 3, and a few noteworthy observations can be pointed out.

First, it is instructive to note that modifications of the premaxillae are much alike in all species of *Salvadora*. On the basis of proportionate tail length, scale characters, and dentition, two infrageneric groups can be segregated in the genus. One of these contains two large species, *lemniscata* and

mexicana, while four smaller species, some of them polytypic, comprise the other group. Even though the premaxillae of all six species are similar, there are minor, but consistent, differences between the snakes in the two groups. The posterolateral projections of the bone are almost completely suppressed in *mexicana* and *lemniscata*, the species with the most poorly developed rostral. Conclusions that may be drawn from a study of premaxillary characters confirm those drawn from other data. It seems clear that the snakes in the genus comprise a natural group that is well differentiated from others.

It may be suggested that the modifications of the rostral that characterize *Salvadora*, the projecting lateral edges and the flattened anterior of the scale, inevitably are accompanied by changes in the premaxillae. It is instructive, therefore, to compare the premaxilla of the patch-nosed snakes (*Salvadora*) with that of the leaf-nosed snakes (*Phyllorhynchus*). The rostral of the latter is flattened in a similar manner and even more strongly enlarged than it is in *Salvadora*. Numerous other scale characters serve to distinguish the genera, although for some years they were believed to be related. *Phyllorhynchus*, however, includes only nocturnal burrowing snakes, whereas the patch-nosed snakes are all diurnal; they are not true burrowers even though most of them are able

to dig in loose soil. But the premaxilla of *Phyllorhynchus* is not modified as it is in *Salvadora*, and shows little departure from what loosely may be referred to as the normal colubrid type.

When other burrowing colubrids are examined, however, some interesting parallels occur. Both *Arizona* and *Rhinocheilus* are crepuscular or nocturnal, and evidently feed while they are on the surface. During the day they presumably remain underground. They glide into loose soil with ease, and are capable of extensive movements beneath the surface. In each of these genera a conspicuous projection that undoubtedly provides support for the snout is present on the middle of the anterior surface of the premaxilla. The bone is strongly attached to the nasal and septomaxillary bones, while the nasals, in turn, are in broad contact with the frontals in *Rhinocheilus*, but somewhat less so in *Arizona*.

In general the modifications of the premaxilla in these burrowing snakes seem to be coupled with the necessity for the firm support of a projecting snout. The lateral projections appear to be retained, or even greatly enlarged, because of the support gained by their attachment to the anterior end of the maxillary bones. This attachment is relatively loose in terrestrial or arboreal snakes, but in burrowers it is more often close, indicating that the maxillae further strengthen the snout. The median projection is essentially hemispherical in *Rhinocheilus*, somewhat less so in *Arizona*, whereas in *Pituophis* the same structure is more like a vertical keel on the premaxilla.

Pituophis is not a burrower, although it is capable of pushing its body through loose earth when this is encountered in the burrows of the pocket gopher, *Thomomys*. Undoubtedly it is closely allied to *Arizona*, as Klauber (1946) infers, and it is not difficult to see how the premaxillary bone evolved from an ancestor not unlike existing *Pituophis*. The median projection of the premaxillae is rather variable in the latter genus, as a matter of fact, and within the species *catenifer* there are various degrees of modification. In the third row from the top in figure 3, two extremes for

Pituophis are represented, with the premaxilla of *Arizona* to the right for comparison. A close parallel in the condition of the premaxilla in *Pituophis* is found in the Asiatic *Coluber spinalis*.

Pope (1935) mentions that this snake inhabits arid regions, despite the fact that it is more abundant in the vicinity of water. It is uncertain whether its habits resemble those of *Pituophis* or *Arizona*, but inferences from the shape of the premaxilla suggest that its ecological requirements might be nearly intermediate between those of the two latter genera. It is virtually certain that *spinalis* is more specialized in its habits than other Eurasian or American snakes currently referred to *Coluber*.

The premaxillary bone of a few natricine snakes has been examined with the hope that it might throw some light on the validity of current arrangements. *Natrix* and *Thamnophis* are readily separable as far as most species are concerned, but a few species are perplexing and could be referred to one genus or the other unless great emphasis is placed on the nature of the anal scute. As so often happens in such instances, however, the variations in the shape of the premaxilla preclude the use of simple statements to describe the differences. The few species of *Natrix* that have been examined tend to have somewhat more pronounced lateral projections on the premaxilla than are usually encountered in *Thamnophis*, but such supposedly annectant species as *rufipunctatus* (long known as *angustirostris*) could as readily be referred to one genus as the other on the basis of premaxillary characters. It is noteworthy, nevertheless, that the premaxilla has a characteristic shape in the two genera, although too few specimens have been examined to warrant the statement that all Natricinae are so characterized. Moreover, something of an approach to the condition seen in *Thamnophis* is observable in *Elaphe*.

Some extremes in specialization are depicted in figure 3, wherein it may be noted, for example, that the lateral processes of the premaxilla are greatly reduced in a South American specimen of *Oxybelis aeneus aeneus*, and virtually lacking in a

Mexican example of the more specialized race *O. a. auratus*. An extreme modification along quite different lines (see fig. 3) is exemplified in the premaxilla of the hog-nosed snake, *Heterodon*.

It is plain, however, that premaxillary characters are useful in elucidating relationships, despite the disadvantages that result from the qualitative nature of the differences. Moreover, there are, of course, individual differences that must be taken into account when comparisons of species or genera are attempted. On the whole the variations, especially at the front of the bone, within a single species are not extensive. The posterior processes, where the premaxilla is attached to the septomaxilla and the nasal, may be single, bifurcated, or even with each branch secondarily bifurcated (as represented by *Salvadora h. deserticola* in fig. 2), and are subject to frequent modification, possibly of ontogenetic but not of phylogenetic significance. All

three conditions occur within a single species.

Needless to say, it is preferable to examine the entire skull rather than a single element of it. Unfortunately it is not always possible to obtain skulls since some museums object to having the entire cranium removed from the skin of preserved specimens belonging to rare species. The premaxilla, however, can be examined from the ventral aspect in most species by the simple expedient of removing the connective tissue that covers the bone behind the rostral at the front of the mouth. In most instances the skin on the snout can be peeled from the premaxilla without seriously distorting the shape of the rostral, and the bone can be examined *in situ*. Often the information gained supplements that derived from a study of the hemipenis, or it may prove to be of greater importance. Premaxillary characters have an additional advantage over the hemipenis in that they are not confined to one sex.

SUMMARY

1. The genus *Leptodrymus* erected by Amaral in 1927 should be reinstated for the species *pulcherrimus*, since its superficial resemblances to snakes in *Salvadora* are not accompanied by similarities in penial, premaxillary, and scale characters. Various peculiarities serve to separate *Leptodrymus* from species in other genera, particularly the symmetrical arrangement of spines on the hemipenis, two of them greatly enlarged with the sulcus spermaticus in the middle. Moreover, the presence of three postoculars in *pulcherrimus* serves to differentiate the species from the allied genera.

2. The results of a brief survey of premaxillary characters point to their usefulness in systematic work. The shape of the premaxilla characterizes the snakes in the genus *Salvadora*, and use of the bone may be of aid in delineating other subfamily, generic, or infrageneric groups. Parallel modifications of the premaxilla in some burrowing snakes are pointed out, although it is plain that these do not seriously obscure the inferences with respect to relationships or phylogenies that may be drawn from comparisons of premaxillae.

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A NEW RANA FROM SAN LUIS POTOSI, MEXICO

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During recent field work in San Luis Potosi state, Mexico, it was found that a considerable population of a pustulose *Rana tarahumarae*-like frog existed along

the Arroyo Sacahuite, a small tributary of the Rio Moctezuma. The present paper is concerned with the taxonomy and general biology of this frog.

1. TAXONOMIC CONSIDERATIONS

STATISTICAL ANALYSIS

In order to make comparisons with Boulenger's types of *Rana tarahumarae*, the measurements chosen for comparison are those used by Boulenger (1920) and believed by the writer to be sufficiently reproducible that comparable measurements can be made on the present material. Table 5 gives measurements of four characters for *Rana tarahumarae*, *R. pustulosa*,

head width ratio, also, shows a significant difference between the Arroyo Sacahuite frogs and *boyliei*, *pustulosa*, *tarahumarae*, and *palmipes*.

It is obvious from casual inspection of body size measurements that frogs of disproportionate size are being compared, and the apparent differences may be due to allometric growth. Body size of the five groups of frogs is as follows:

	N	$m \pm \sigma m$	Range
Arroyo Sacahuite	21	51.05 ± 1.58 mm.	38 - 62 mm.
<i>R. pustulosa</i>	20	67.70 ± 1.70	56.3- 88.0
<i>R. boyliei</i>	6	44.25 ± 5.59	32.5- 75.5
<i>R. palmipes</i>	40	83.00 ± 1.92	66.1-109.0
<i>R. tarahumarae</i>	23	59.75 ± 3.11	42.0- 97.2

R. palmipes, *R. boyliei*, and Arroyo Sacahuite frogs. The following ratios were computed: body length/head length, body length/hind limb length, and head length/head width (tables 1, 2).

If a Critical Ratio (C.R.) of 2.5 be considered as significant, the Arroyo Sacahuite frogs differ significantly, with respect to body/head ratio, from *boyliei* and *tarahumarae*, but not from *pustulosa* or *palmipes*. Body/hind limb ratio shows a significant difference between Arroyo Sacahuite frogs and *boyliei*, *pustulosa*, *tarahumarae*, and *palmipes*. Head length/

Two methods of comparing such samples are available: (1) compare like size groups, and (2) where like size groups are not available, determine the presence or absence of allometric growth, and, if allometric growth is involved, make the necessary correction.

If we take the five smallest *boyliei* ($m = 38.45 \pm 2.00$ mm.; range 32.5-52.7 mm.) and the six smallest Arroyo Sacahuite frogs ($m = 42.33 \pm 1.35$ mm.; range 38-46 mm.) we have reasonably equivalent samples. Computed means for the ratios are as follows:

	Body Length/ Head Length $m \pm \sigma m$	Body Length/ Hind Limb Length $m \pm \sigma m$	Head length/ Head Width $m \pm \sigma m$
5 smallest <i>boyliei</i>	2.94 ± 0.10	0.58 ± 0.02	0.87 ± 0.02
6 smallest Arroyo Sacahuite	2.60 ± 0.05	0.69 ± 0.01	1.04 ± 0.02

¹ Department of Animal Behavior.

Means differ significantly for the two samples for each of the three ratios (C.R.'s of 3.1, 5.3, and 5.5, respectively). This is the same result as that obtained with whole samples.

When the 10 smallest *pustulosa* ($m = 61.95 \pm 1.23$ mm.; range 56.3–67.5 mm.)

upon any difference in body/head length ratio between *pustulosa* and the Arroyo Sacahuite frogs.

Computation of means for the 16 smallest *tarahumarae* (body size: $m = 51.75 \pm 1.95$ mm.; range 42.0–65.0 mm.) gives the following results:

	Body Length/ Head Length $m \pm \sigma m$	Body Length/ Hind Limb Length $m \pm \sigma m$	Head Length/ Head Width $m \pm \sigma m$
16 smallest <i>tarahumarae</i>	2.84 ± 0.04	0.63 ± 0.01	0.94 ± 0.01
All Arroyo Sacahuite frogs	2.69 ± 0.06	0.67 ± 0.01	1.03 ± 0.01

are taken for comparison with the 10 largest Arroyo Sacahuite frogs ($m = 56.5 \pm 1.17$ mm.; range 52–62 mm.) the means for the three ratios under consideration are as follows:

These animals are of comparable size to the Arroyo Sacahuite series. They differ from that series with respect to body/hind limb and head length/head width ratios (C.R.'s of 2.9 and 6.4, respectively),

	Body Length/ Head Length $m \pm \sigma m$	Body Length/ Hind Limb Length $m \pm \sigma m$	Head Length/ Head Width $m \pm \sigma m$
10 smallest <i>pustulosa</i>	2.60 ± 0.03	0.62 ± 0.00	0.94 ± 0.01
10 largest Arroyo Sacahuite	2.78 ± 0.05	0.66 ± 0.01	1.02 ± 0.02

Means differ significantly for the two samples for the ratios body/hind limb and head length/head width (C.R.'s of 3.7 and 3.8, respectively), which is the result found with whole samples. However, body/head length ratio, which did not show a significant difference between the two whole samples, now differs significantly (C.R. = 3.1). For a further check on this matter, the six smallest *pustulosa* ($m = 59.25 \pm 0.93$ mm.; range 56.3–64.0 mm.) were compared with the six largest Arroyo Sacahuite frogs ($m = 59.16 \pm$

but do not differ with respect to body/head length ratio (C.R. = 2.1).

No direct comparison of Arroyo Sacahuite frogs and *palmipes* is possible, since the mean body size of the former is 51.05 ± 1.58 mm. (range 38–62 mm.), while that of the latter is 83.00 ± 1.92 mm. (range 66.1–109.0 mm.). If the *palmipes* are divided into two groups, those of 66.0–87.9 mm. body size (av. 75.75 ± 1.16 mm.) and those of 88.0–109.9 mm. body size (av. 98.00 ± 1.96 mm.), the following means for the ratios for the two groups are obtained:

	N	Body Length/ Head Length $m \pm \sigma m$	Body Length/ Hind Limb Length $m \pm \sigma m$	Head Length/ Head Width $m \pm \sigma m$
66.0–87.9 mm. <i>palmipes</i>	27	2.64 ± 0.01	0.62 ± 0.01	0.99 ± 0.01
88.0–109.9 <i>palmipes</i>	13	2.70 ± 0.02	0.65 ± 0.01	0.96 ± 0.01

0.96 mm.; range 56–62 mm.). Means for body/hind limb length ratio are as follows:

	$m \pm \sigma m$
6 smallest <i>pustulosa</i>	2.62 ± 0.04
6 largest Arroyo Sacahuite frogs	2.72 ± 0.04

This gives a C.R. of 1.6 for the two samples. Since the two samples are so nearly equal in body size, serious doubt is cast

The 66.0–87.9 mm. *palmipes* differ significantly from 51–62 mm. Arroyo Sacahuite frogs with respect to body/head and body/hind limb ratios (C.R.'s of 2.6 and 3.5, respectively) but not with respect to head length/head width ratio (C.R. 1.7). For body/hind limb ratio this is the same result as that secured with whole samples;

for the other two ratios the result is not the same as that secured with whole samples. The 66.0–87.9 mm. *palmipes* and 88.0–109.9 mm. *palmipes* do not differ significantly (C.R. = 2.1) with respect to head length/head width ratio. Serious doubt is cast upon the validity of any difference between *palmipes* and Arroyo Sacahuite frogs. The differences between 66.0–87.9 mm. *palmipes* and 88.0–109.9 mm. *palmipes* with respect to body/head and body/hind limb ratios are, however, significant and merit further consideration. Let us divide the *palmipes* into four groups. Means are as follows:

	N
66.0–76.9 mm. <i>palmipes</i>	15
77.0–87.9 <i>palmipes</i>	12
88.0–98.9 <i>palmipes</i>	6
99.0–109.9 <i>palmipes</i>	7

Comparison of 66.0–76.9 mm. *palmipes* to 56–64 mm. Arroyo Sacahuite frogs with respect to body/head and body/hind limb ratios shows no significant difference (C.R.'s of 1.9 and 2.1 for body/head and body/hind limb ratios, respectively). However, there are indications of allometric growth in *palmipes* with respect to both body/head and head/hind limb ratios, and animals of 61 mm. body size might be expected to have body/head and body/hind limb ratios of approximately 2.61 and 0.61, respectively. Assuming the standard deviations of this hypothetical sample to be about the same as those for the known *palmipes* groups, *palmipes* does not differ from Arroyo Sacahuite frogs with respect to body/head ratio (C.R. 2.3), but does differ with respect to body/hind limb ratio (C.R. 2.8).

In summary, then, Arroyo Sacahuite frogs differ in body/head length ratio from *boyliei* only. In body/hind limb ratio Arroyo Sacahuite frogs differ from *boyliei*, *pustulosa*, *tarahumarae*, and *palmipes*. In head length/head width ratio Arroyo Sacahuite frogs differ from *boyliei*, *pustulosa*, and *tarahumarae*.¹

¹ Some of these differences, it must be emphasized, are differences between local populations, and may or may not represent differences between species. The following example illustrates the fallacy of any

SPECIES COMPARISON

All but one of the Arroyo Sacahuite frogs exhibit a prominent white stripe extending from below the anterior edge of the eye posteriorly along the upper edge of the maxilla, under the tympanum, to the anterior edge of the insertion of the fore limbs. Some indication of such a stripe appears in some individuals of each of the four species: *R. tarahumarae*, *R. pustulosa*, *R. palmipes*, and *R. boyliei*. Of the four species, it is best developed in *palmipes*, but even here it is variable, irregular, broken, and cream color.

Body Length/ Head Length m $\pm$ σ m	Body Length/ Hind Limb Length m $\pm$ σ m
2.63 $\pm$ 0.02	0.62 $\pm$ 0.01
2.65 $\pm$ 0.02	0.63 $\pm$ 0.01
2.70 $\pm$ 0.02	0.64 $\pm$ 0.01
2.70 $\pm$ 0.03	0.66 $\pm$ 0.01

The tympanum is small, one-half the diameter of the eye or less, in the Arroyo Sacahuite frogs. A similar condition is found in *pustulosa*, *boyliei*, and *tarahumarae*. In *palmipes* the tympanum is from one-half to five-sixths the diameter of the eye.

The Arroyo Sacahuite frog and each of the four species mentioned above have a glandular fold running from the posterior edge of the eye above the tympanum to the shoulder. It is best developed in *tarahumarae*. In the Arroyo Sacahuite frogs and the other three species it is variable, ranging from absent to moderately well developed.

Prominent dorsolateral folds are present in *palmipes*. In *pustulosa* and *boyliei* the situation is rather variable, with well-developed folds in some individuals and

premature conclusion as to species differences. A collection of American toads (*Bufo americanus*) was made at Tulsa, Oklahoma; these animals had a body/foot ratio of 1.69 $\pm$ 0.02. A collection of Fowler's toads from Lakeville, Massachusetts, showed a body/foot ratio of 1.53 $\pm$ 0.01. Since the difference is statistically significant (C.R. = 7.1) it is easy to conclude that Fowler's toad and the American toad differ as to body/foot ratio. However, another collection of Fowler's toads from Jena, Louisiana, showed a body/foot ratio of 1.70 $\pm$ 0.01, which does not differ significantly (C.R. = 0.4) from the ratio for the Tulsa collection of American toads. And a second collection of American toads, this time from Bloomington, Indiana, showed a body/foot ratio of 1.53 $\pm$ 0.01, which is identical with the ratio for Lakeville Fowler's toads.

indistinct folds in others. In *tarahumarae* and the Arroyo Sacahuite frogs there are no folds, although there is a slight indication of folds in some individuals.

The Arroyo Sacahuite frogs and the four species cited above agree in having a pustular dorsum. In size and number of pustules *tarahumarae* closely resembles the Arroyo Sacahuite frogs. The other three species are less pustular than the Arroyo Sacahuite frogs, although the pustules average somewhat larger in size.

The venter in the Arroyo Sacahuite frogs

oval and rounded in *pustulosa*, *palmipes*, *tarahumarae*, and *boylhi*. Those of *pustulosa* show some resemblance to those of the Arroyo Sacahuite frogs.

In the Arroyo Sacahuite frogs the toe disks are large, rounded, flat, and free from the web. They are smaller, less rounded, less flat, and less free from the web in *pustulosa*, *palmipes*, and *tarahumarae*. In *boylhi* they are small and not at all prominent; webbing is about the same as in the Arroyo Sacahuite frogs.

No *Rana sierramadrensis* are available



Fig. 1. *Rana moorei*, male, A.M.N.H. No. 52924, $\times 1.8$.

is white, with a light gray suffusion on the throat in some instances. In *tarahumarae* and *boylhi* the venter is light. In *pustulosa* the venter frequently has a suffusion of gray, and in *palmipes* it usually is heavily marbled.

The Arroyo Sacahuite frogs have a single metatarsal tubercle, as do *pustulosa*, *palmipes*, and *tarahumarae*; *boylhi* has two metatarsal tubercles.

The subarticular tubercles of the hind feet of the Arroyo Sacahuite frogs are elongated and knife-like. They are more

for comparison. From the type description of this form (Taylor, 1938) it appears that the Arroyo Sacahuite frogs resemble it in having a light jaw stripe and differ from it, among other things, in lacking a dorso-lateral fold.

SPECIES DESCRIPTION

In view of the differences cited it seems necessary to describe the Arroyo Sacahuite frogs as a new species.

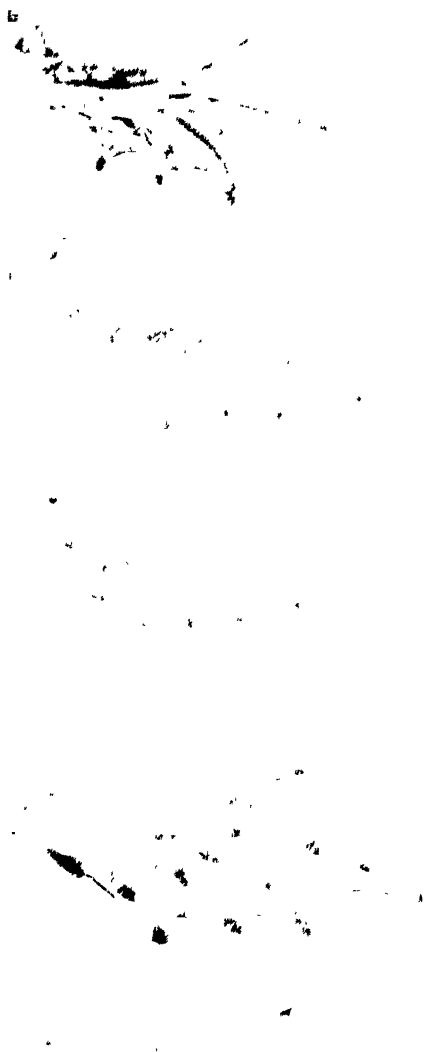


Fig. 2. Foot structure of *Rana moorei* and related species, $\times 1$. From top to bottom: *Rana palmipes*, A.M.N.H. No. 44557; *Rana pustulosa*, A.M.N.H. unnumbered, Cuicatlan, Oaxaca, Mexico; *Rana moorei*, A.M.N.H. No. 52918; *Rana tarahumarae*, U.M.M.Z. No. 75743; *Rana boylei*, A.M.N.H. No. 52219.

Rana moorei,¹ new species

TYPE: A.M.N.H. No. 52908, collected on the Arroyo Sacahuite at Palietla, 6 miles (by highway) north of Tamazunchale, San Luis Potosi, Mexico, September 9, 1946. Collectors: A. P. Blair and J. A. Moore.

PARATYPES: A.M.N.H. Nos. 52903-52907, 52909-52923, collected at same locality September 9, 1946, same collectors, and A.M.N.H. No. 52924, collected at same locality September 2, 1946, by A. P. Blair and C. M. Bogert.

DIAGNOSIS: A medium-sized frog allied to *Rana tarahumarae* and *R. pustulosa*. Head usually longer than broad. A white stripe from below eye to insertion of arm. Toe disks very well developed, round, flat, free from web. Subarticular tubercles elongated, knife-like. No dorsolateral fold.

DESCRIPTION (FIGS. 1, 2): Color in life dark olive green above, very light or white below. Dorsal surface of hind legs with dark transverse bands. A white stripe from below eye to insertion of arm. Many small pustules on dorsal surface. Head depressed, as long as or longer than wide. Tympanum one-half diameter of eye or less. One metatarsal tubercle. Subarticular tubercles elongated, knife-like. Toe disks very well developed, round, flat, free from web. The type specimen is a male and shows an enlarged thumb. Snout-vent length 62 mm.; an 81-mm. male was observed during marking experiments.

RELATIONSHIP: Probably most closely related to *Rana tarahumarae* and *R. pustulosa*. Precise determination of relationship must await additional specimens from many localities, as well as a much better understanding of the Mexican species of *Rana*. *Rana moorei* may be restricted to rocky arroyos (fig. 3); intensive collecting along the Rio Axtla (fig. 4), 15 miles north of the Arroyo Sacahuite, yielded only *Rana pipiens*. No other *Rana* of the species complex to which *R. moorei* belongs has been taken in the immediate vicinity of the type locality (fig. 5).

¹ The studies of John A. Moore on temperature tolerance, rate of development, hybridisation, and taxonomy of North American frogs of the genus *Rana* have done much to further understanding of this group. It is a pleasure to name the new species *Rana moorei*.

2 BIOLOGICAL CONSIDERATIONS

THE HABITAT

The elevation at Palictla is approximately 400 feet. The Arroyo Sacahuite is a small stream (figs. 3, 6) which arises in the mountains to the west of Palictla and flows generally southeast until it enters the Rio Moctezuma a few miles below Palictla. The water is clear. For the most part the stream bed is rocky, either massive limestone in place or coarse pebble and cobble gravel. In some of the quieter, deeper pools there is a thin layer of silt on the bottom. The general stream pattern is one of pools separated by shallow, rocky, swift riffles. The depth of the deepest pools (pools K and Q) is about 24 inches. On the last day of observations, September 9, the water level was approximately 2 inches lower than previously; this difference was most apparent in the riffles, in some of which the flow of water was now below the surface of the gravel. The greatest width of the stream is 25 feet. The banks of the stream are clear, with heavy undergrowth beginning 2 to 15 feet from the edge of the

stream. No surface water plants are evident, but most pools contain beds of green algae. Algae are present in greatest mass in pools A, J, K, and M. Fish (several species, up to 6 inches in length), crayfish (probably three species), and snails constitute the most conspicuous aquatic forms other than Salientia.

The water of the stream is rather warm, as shown by the following temperature records made in the swift riffle between pools C and D:

	Time	Temperature
September 4	10 00 A.M.	25 4° C.
	11 00 A.M.	26 4°
	12 00 NOON	27 1°
	1 00 P.M.	29 0°
	2 00 P.M.	30 7°
	3 00 P.M.	31 6°
	4 00 P.M.	32 0°
	5 00 P.M.	30 0°
	6 00 P.M.	30 1°
	7 00 P.M.	29 3°
September 5	11 00 P.M.	27 5°
	8 30 A.M.	25 0°
September 6	3 00 P.M.	30 6°
	9.30 A.M.	24 9°

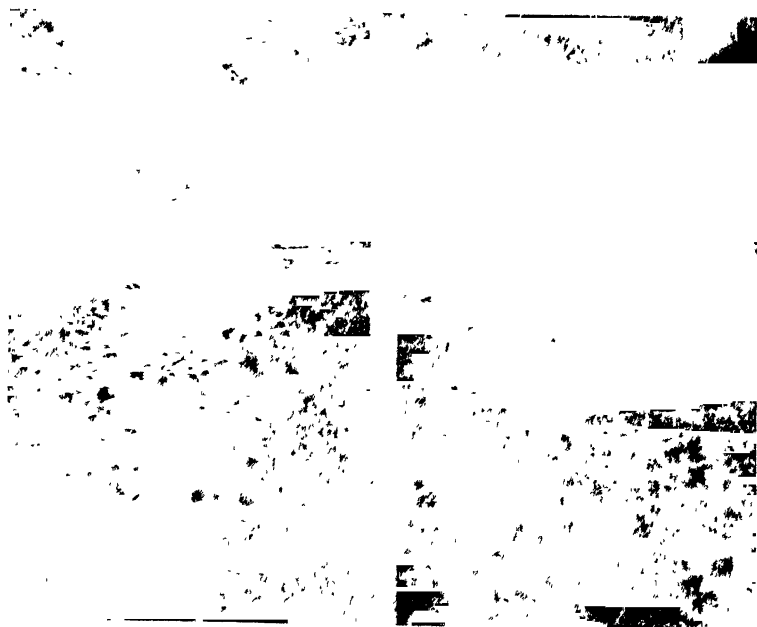


Fig. 3. Two views along the Arroyo Sacahuite. Left, pool D, looking downstream; right, pool K, looking downstream

September 4 was a bright, sunshiny day with few clouds; the afternoon of September 5 the sun was obscured a considerable portion of the time. Isolated shaded pools without running water connection with the stream may remain considerably cooler. Two such pools showed temperatures of 25.4 and 26.6° C., respectively, at 3:00 p.m., September 6.

MARKING EXPERIMENTS

The degree to which an organism tends to be migratory or fixed in habit greatly affects the role of random gene fluctuation,

A portion of the creek some 2000 feet in length was selected for investigation (figs. 3, 6). The procedure each night was to enter the creek at the lower end of pool G, where an Indian trail crosses the creek, proceed downstream to the lower end of pool S, then upstream to the riffle above pool A, and, finally, downstream to the point of entry at pool G. This procedure took some three to five hours. As frogs were encountered, they were caught by hand, measured with vernier calipers for body length, sex recorded if the thumb pads were unquestionably enlarged, individually



Fig. 4. Rio Axtla.

selection, and hybridization in the production of genetically distinct local populations. Little is known of population size and migratory or sedentary tendencies in the North American frogs. The suggestive work of Breder, Breder, and Redmond (1927) on the green frog (*Rana clamitans*) and Raney (1940) on the green frog and bullfrog (*R. catesbeiana*) indicates that some individuals may be relatively sedentary over a period of several months while others wander freely.

marked by toe clipping, and released at the point of capture. On the final night, September 9, most of the animals collected were shot with .22 caliber shot shells.

Details of capture and recapture are given in table 3 and figures 7 and 8. Fourteen animals were marked the first night (September 2), six the second night (September 3), five the third night (September 4), and six the fourth night (September 5); nine unmarked animals were collected on the final night (September 9). On the

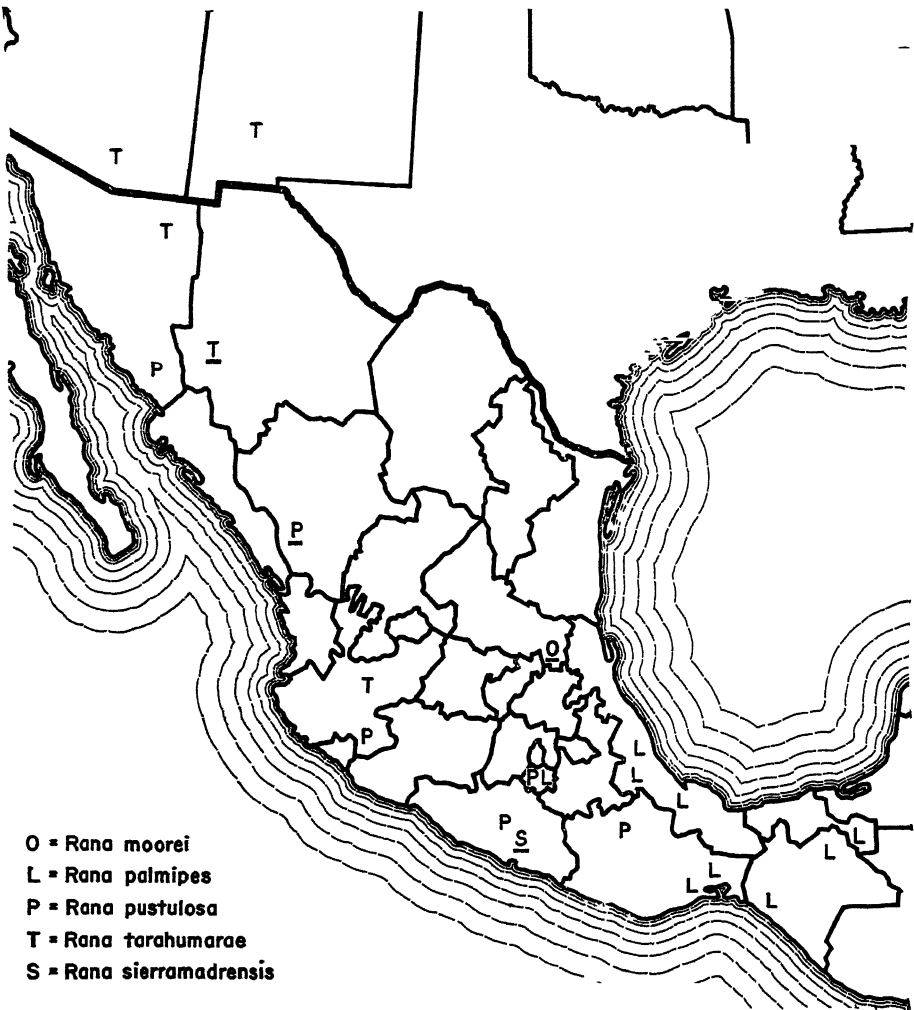


Fig. 5. Distribution of *Rana moorei* and related species; type localities underlined.

second night eight frogs marked the previous night were recovered; all were in the pools where marked and within 20 feet of the point where marked. The third night six frogs marked the first night and four the second night were recovered; all were in the pools where marked and within 20 feet of the point where marked. The fourth night three frogs marked the first night, two the second night, and three the third night were recovered. Five of the eight frogs were in the pools where marked and within 20 feet of the point where marked.

No. 3 moved across a gravel bar and 35 feet upstream. No. 15 moved from pool J to pool K, a distance of only 10 feet. No. 24 moved from pool G upstream some 235 feet to pool D. On the last night six frogs marked the first night, four the second night, none the third night, and two the fourth night were recaptured. No. 3 was at the upper end of pool N, some 40 feet downstream from where marked in pool M. No. 10 was at the lower end of pool E, some 50 feet upstream from where marked in pool G. No. 17 was in the small brook

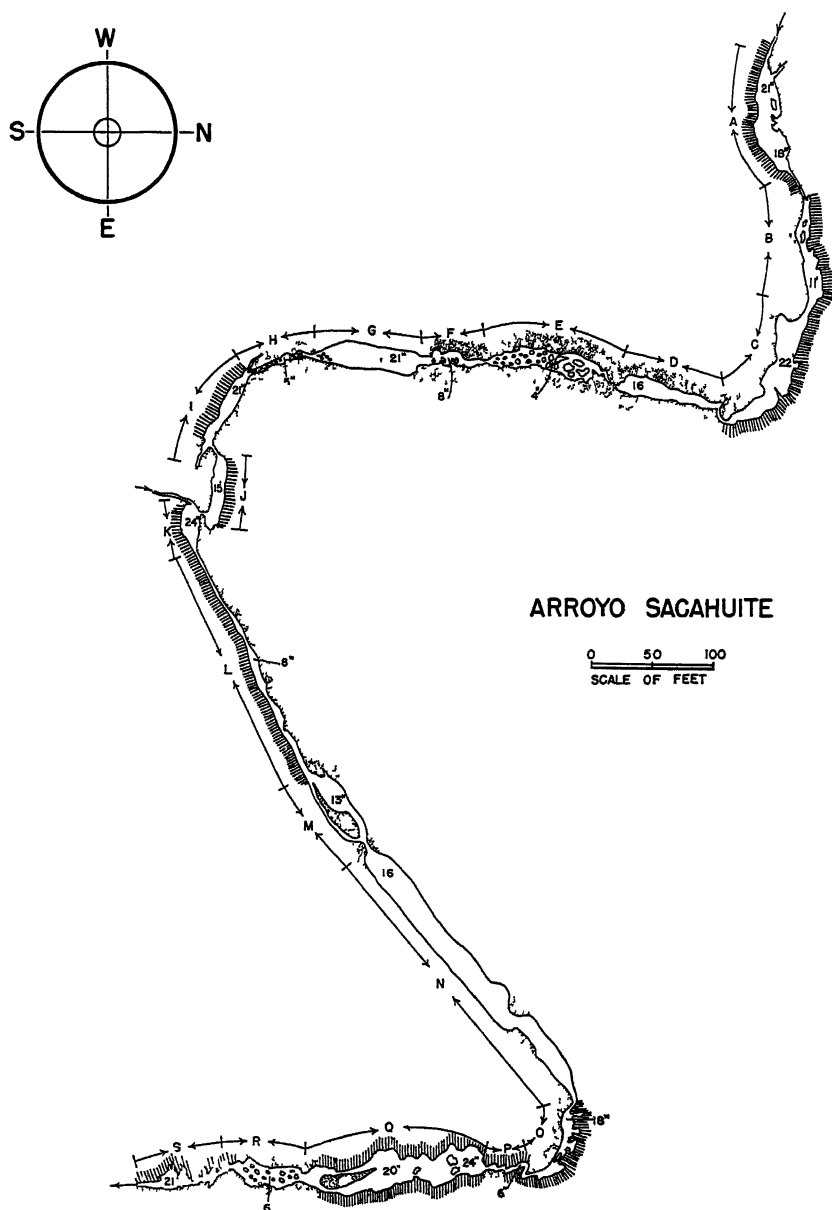


Fig 6. The Arroyo Sacahuite: physical features. Stippled areas are gravel bars; parallel line marked areas are rock in place; numbers represent maximum depths of pools.

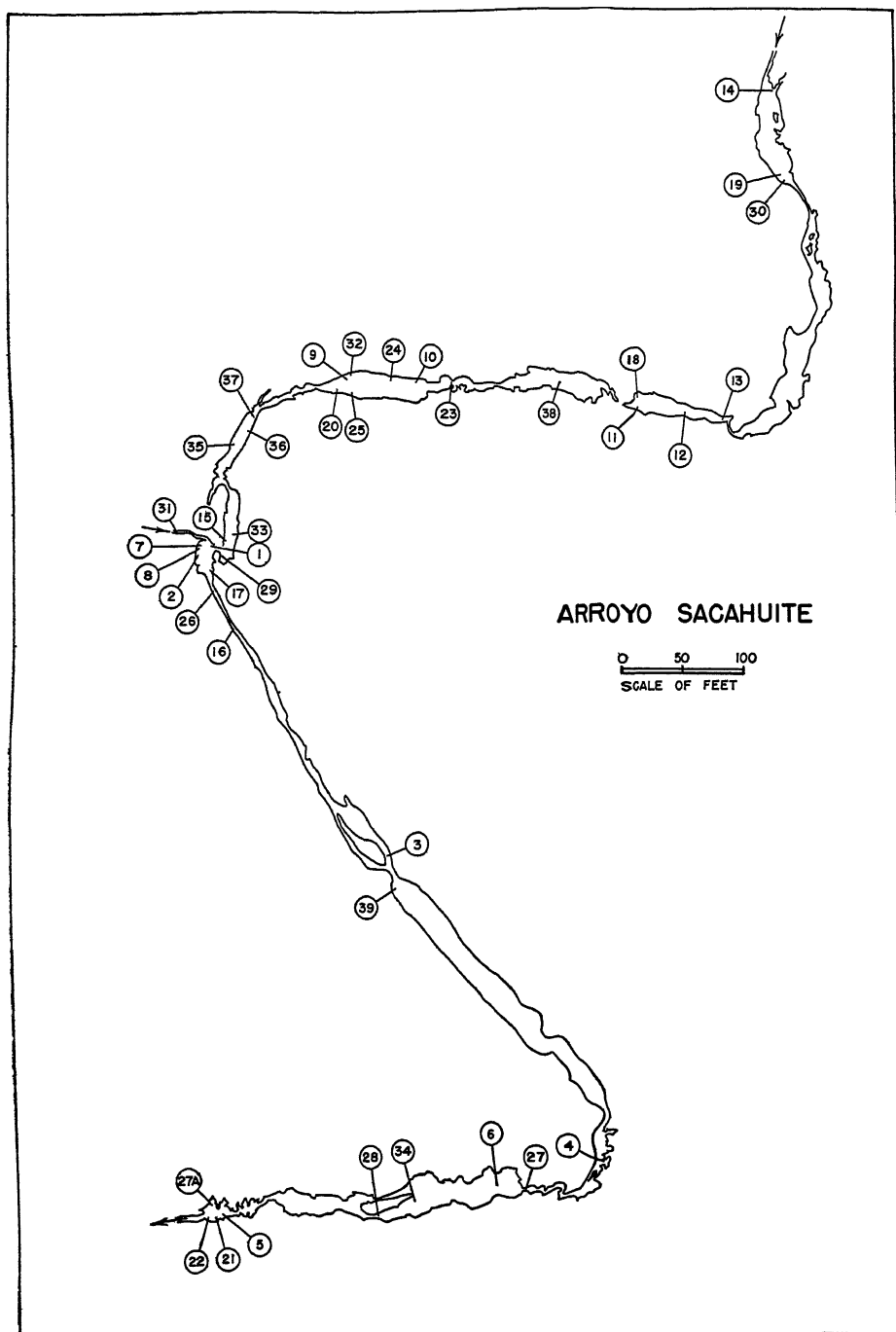


Fig. 7. The Arroyo Sacahuite: points at which frogs were collected; numbers correspond to field numbers of frogs.

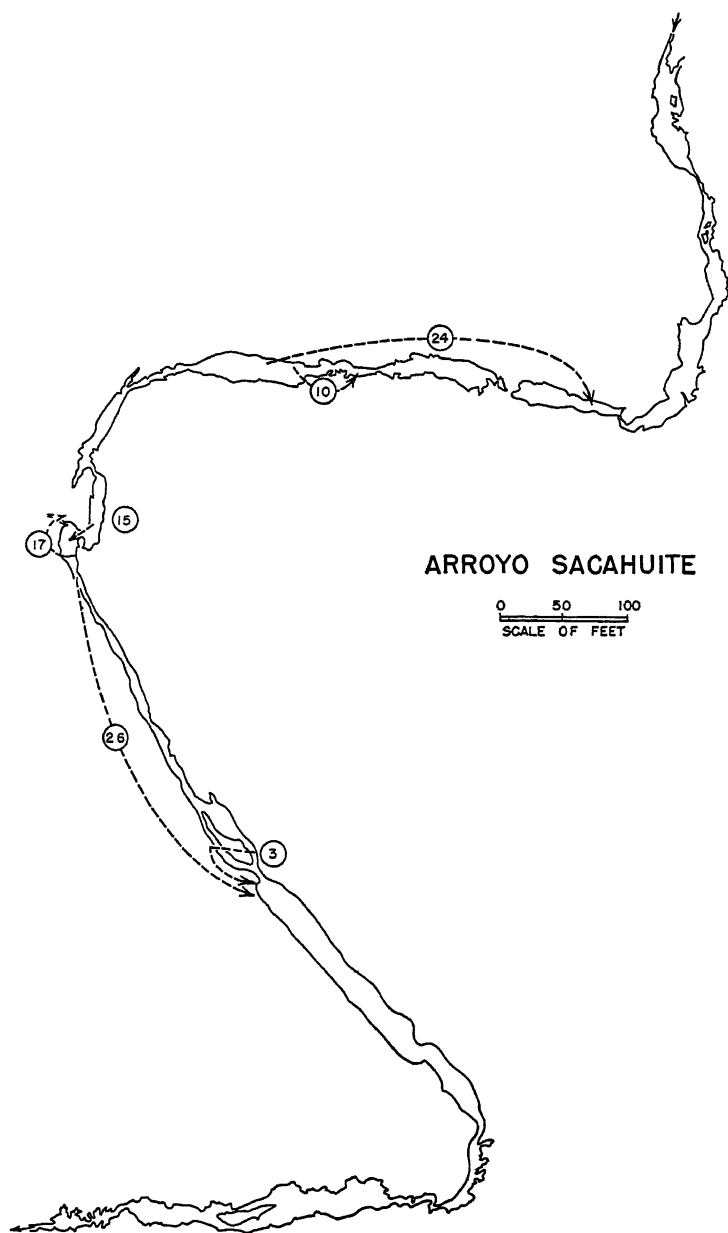


Fig. 8. The Arroyo Sacahuite: migrations of frogs; numbers correspond to field numbers of frogs.

which runs into the upper end of pool K. No. 26 was at the lower end of pool M, some 280 feet downstream from the point where marked at the upper end of pool L. The remaining eight were in the pools where marked and within 20 feet of the point where marked. Of the total of 30 animals marked previous to the last night, 23 were recovered at least once, nine two times each, and three three times each.

Whether the unmarked frogs captured subsequent to the first night represent animals which migrated in from outside the area of investigation, animals which were seen but not captured the first night, or animals not abroad the first night is not completely apparent. Examination of the area was sufficiently intensive that it is believed that few frogs which were abroad escaped detection. With a water temperature of 27° C. it hardly seems possible that animals might remain submerged for any considerable length of time. No animal was ever found more than a few inches from water, but it is not impossible that animals occasionally leave the stream and remain in the forest for days at a time. Animals were agile and sometimes eluded capture, but it is believed impossible that the number of frogs collected the last night can be explained on this basis. The remaining possibility is that animals were continually migrating into and out of the area of investigation. In view of findings this seems possible. Probably no valid inference as to population density, other than the number observed on a single night, can be drawn. For the last night of collecting the population density can be given as a minimum of 25 individuals (21 collected plus four which escaped) for the 2000-foot stretch of stream.

No strict correlation of concentration of frogs with type of pool was found. The greatest concentrations were in pool D (4 frogs), pool G (6 frogs), pool K (5 frogs), and pool S (4 frogs). Pool D is of moderate to shallow depth with stream bed of large cobbles (6-15 inches diameter). Pool G is deep with silt bottom and banks. Pool K, a deep gravel and rock-bottomed pool, has much algae. Pool S is much the same but with little algae. Some frogs were found in

shallow, rocky riffles. The largest animal found (No. 22, 81 mm. body length) was in pool S. No frog was found in pool I for four successive nights. This pool has smooth bottom and banks affording little in the way of cover. On the final night, however, three frogs were in this pool.

Many of the animals observed were juveniles. All females captured the last night were small (38-49 mm.) and had immature ovaries. Two of the larger animals (62 and 81 mm.) were definitely determined as males in the field on the basis of enlarged thumb pads. Laboratory comparison of males and females (determination based on gonads) shows thumb enlargement in Nos. 5, 10, 17, 18, 19, 25, 33, and 34. Evidently, then, males begin showing secondary sex characters at a body length of 55-60 mm. when the testes are 5-8 mm. in length. The finding of 15 males to 7 females is well within sampling limits for a 1/1 sex ratio.

FOOD HABITS

The contents of the digestive tracts of 22 animals were found to be as follows:

A.M.N.H.

No.	
52903	Tipulid legs (Diptera), spider legs
52904	Two spiders
52905	Five roaches (Blattidae, Orthoptera), of two species
52906	One spider, one caddis fly (Trichoptera)
52907	One spider, caddis fly scales
52908	One bug (Pentatomidae, Hemiptera), one lepidopterous caterpillar
52909	One Trichoptera or Lepidoptera
52910	One spider
52911	One spider, one damsel fly (Zygoptera, Odonata), one lepidopterous caterpillar (?)
52912	One caddis fly (Trichoptera)
52913	One beetle (Gyrinidae, Coleoptera)
52914	One Hemiptera, one Trichoptera or Lepidoptera
52915	One Hemiptera (Neididae?), one Coleoptera, two spiders
52916	Spider legs, one ant (Formicidae, Hymenoptera), two Coleoptera
52917	One Lepidoptera
52918	One spider, one caterpillar (Lepidoptera), one beetle (<i>Gyrinus</i> , Gyrinidae, Coleoptera)
52919	One damsel fly (Zygoptera, Odonata), one beetle (Hydrophilidae, Coleoptera)
52920	One Lepidoptera

- 52921 One spider, one Hemiptera, one Orthoptera (Blattidae?)
52922 One water bug (Belostomatidae, Hemiptera), one crayfish (*Paracambarus*?)
52923 One ant (Formicidae, Hymenoptera)
52924 One damsel fly (Coenagrionidae, Zygoptera, Odonata)

The food consists of diurnal, nocturnal, and crepuscular forms. There was bright moonlight on the night of September 9, when all animals except No. 52924 were collected; No. 52924 was collected in daylight. While all food items found were Arthropoda, it is obvious that *Rana moorei* is not very selective in its diet. Food consists of aquatic forms, or forms which can be secured at the edge of the stream.

PREDATORS

At night the frogs were found in shallow water near the edge of the creek, or on boulders projecting above the water in the creek. On several occasions they were seen swimming in the deeper pools. When disturbed they never jumped into the undergrowth along the stream, as the leopard frogs habitually did, but dove into the water and sought refuge under boulders, rock ledges, or beds of algae. They were exceedingly agile and elusive and slow moving predators would probably secure few. Of the 40 animals examined, only one

(No. 27A) had a limb missing; this animal had lost the left rear foot.

It is probable that the very large leopard frogs, *Rana pipiens*, which are common along the stream, occasionally eat the smaller frogs. Kilby (1945) found leopard frogs, tree frogs, and cricket frogs in the stomachs of Florida leopard frogs. However, the most important predator is probably *Leptodeira maculata*, a rear-fanged snake known to feed on frogs. Four *L. maculata* were seen: one on the gravel bar at the edge of the water at pool L, one on the mud flat at the edge of the water at pool M, one swimming in the water at the upper end of pool Q, and one endeavoring to subdue a small leopard frog, which it had seized by one hind foot, on the rocky bank of pool R.

While the frogs were much more active at night, on four occasions single frogs were seen in the daytime. Several potential diurnal predators were observed. Egrets were common along the stream, and green and little blue herons were seen several times. There was a domestic pig wallow near the upper end of pool C, and it seems possible that pigs occasionally secure frogs. On one occasion Indians were seen turning over stones in the riffle at the head of pool Q; while the food item sought was crayfish, it seems unlikely that frogs would be rejected.

ACKNOWLEDGMENT

Many persons have aided in one way or another and the writer expresses his gratitude. Dr. J. A. Moore assisted in the arduous marking experiment, took the pictures of the type specimen and type locality, and subsequently read the manuscript. Mr. C. M. Bogert aided in the field work, took the picture of the Rio Axtla, made available the collection of the Department of Amphibians and Reptiles of the American Museum, and read the manuscript. Drs. L. R. Aronson and J. A. Oliver also read the manuscript and made

suggestions. For loan of the Michigan and Cornell specimens the writer is indebted to Messrs. Norman Hartweg and A. H. Wright, respectively. The stomach contents identifications were made by Dr. M. A. Cazier (insects) and Dr. J. C. Armstrong (crayfish). Miss Bessie L. Matalas helped with the assembling of the specimens from the Department of Amphibians and Reptiles. Mrs. Ethel Specker made the enlargement of the photograph of the type specimen.

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TABLE 1
MEANS FOR VARIOUS RATIOS

	N	Body Length/ Head Length m $\pm$ σ m	Body Length/ Hind Limb Length m $\pm$ σ m	Head Length/ Head Width m $\pm$ σ m
Arroyo Sacahuite	21	2.69 $\pm$ 0.06	0.67 $\pm$ 0.01	1.03 $\pm$ 0.01
<i>R. pustulosa</i>	20	2.66 $\pm$ 0.03	0.63 $\pm$ 0.01	0.93 $\pm$ 0.01
<i>R. boylii boylii</i>	6	2.95 $\pm$ 0.08	0.58 $\pm$ 0.01	0.86 $\pm$ 0.02
<i>R. palmipes</i>	40	2.66 $\pm$ 0.01	0.63 $\pm$ 0.01	0.98 $\pm$ 0.01
<i>R. tarahumarae</i>	23	2.86 $\pm$ 0.03	0.63 $\pm$ 0.01	0.93 $\pm$ 0.01

TABLE 2
CRITICAL RATIOS

	Body Length/ Head Length	Body Length/ Hind Limb Length	Head Length/ Head Width
Arroyo Sacahuite: <i>R. pustulosa</i>	0.4	3.9	7.0
Arroyo Sacahuite: <i>R. b. boylii</i>	2.5	5.6	6.9
Arroyo Sacahuite: <i>R. palmipes</i>	0.4	3.9	4.0
Arroyo Sacahuite: <i>R. tarahumarae</i>	2.5	2.9	7.1

TABLE 3
RECOVERY OF MARKED *Rana moorei*, WITH SEX AND TESTIS SIZE FOR THOSE RECOVERED SEPTEMBER 9

	Field No. of Frog	Body Length (mm.)	Sex	Testis Length (mm.)	Sept. 3	Dates Recovered			Sept. 9
						Sept. 4	Sept. 5		
Marked Sept. 2	1	54	♂	2.8	—	—	X		X
	2	55	—	—	X	X	X		—
	3	45	♀	—	—	—	X		X
	4	40	—	—	X	—	—		—
	5	62	♂	5.2	X	—	—		X
	6	50	—	—	X	X	—		—
	7	60	—	—	—	—	—		—
	8	48	♂	4.0	—	—	—		X
	9	45	—	—	—	X	—		X
	10	62	♂	6.7	X	X	—		X
	11	49	—	—	—	—	—		—
	12	47	—	—	X	—	—		—
	13	48	—	—	X	X	—		—
	14	44	—	—	X	X	—		—
Marked Sept. 3	15	42	♂	4.7	—	—	X		X
	16	53	—	—	—	X	—		—
	17	56	♂	6.4	—	X	X		X
	18	61	♂	6.4	—	X	—		X
	19	57	♂	5.3	—	—	—		X
	20	43	—	—	—	X	—		—

TABLE 3—Continued

	Field No. of Frog	Body Length (mm.)	Sex	Testis Length (mm.)	Sep ⁺ . 3	Dates Recovered		
						Sep ⁺ . 4	Sep ⁺ . 5	Sep ⁺ . 9
Marked Sept. 4	21	52	—	—	—	—	—	—
	22	80	♂ ^a	—	—	—	X	—
	23	63	—	—	—	—	—	—
	24	64	—	—	—	—	X	—
	25	65	—	—	—	—	X	—
Marked Sept. 5	26	54	♂	6.5	—	—	—	X
	27	61	—	—	—	—	—	—
	27a	61	—	—	—	—	—	—
	28	43	—	—	—	—	—	—
	29	38	♀	—	—	—	—	X
	30	46	—	—	—	—	—	—
Marked Sept. 9	31	38	♂	2.2	—	—	—	—
	32	55	♂	5.2	—	—	—	—
	33	60	♂	5.8	—	—	—	—
	34	57	♂	8.5	—	—	—	—
	35	49	♀	—	—	—	—	—
	36	52	♀	3.3	—	—	—	—
	37	49	♀	—	—	—	—	—
	38	46	♀	—	—	—	—	—
	39	49	♀	—	—	—	—	—

^a Field determination based on thumb pads.TABLE 4
MATERIAL EXAMINED

22	Arroyo Sacahuite frogs	A.M.N.H. ^a	Nos. 52903-24
20	<i>Rana tarahumarae</i>		
	2 Oblatos, Jalisco, Mexico	A.M.N.H.	Nos. 12533-34 ^b
	1 Pilares 10 N., Sonora, Mexico	U.M.M.Z.	No. 78339
	8 El Tigre Mts., Sonora, Mexico	U.M.M.Z.	Nos. 78340-1
	9 Peña Blanca Spring, Santa Cruz Co., Ariz.	U.M.M.Z.	Nos. 75743-5
		C.U.	No. 3299
20	<i>Rana pustulosa</i>		
	19 Cuicatlan, Oaxaca, Mexico	A.M.N.H.	Nos. 52040-4
			14 unnumbered
	1 Guirocoba, Sonora, Mexico	A.M.N.H.	No. 51224 ^b
42	<i>Rana palmipes</i>		
	40 British Guiana	A.M.N.H.	Nos. 44555-74
	2 Santa Maria Chimalapa, Oaxaca, Mexico	A.M.N.H.	Nos. 51818-9
6	<i>Rana boylei boylei</i>		
	1 Mill Valley, California	A.M.N.H.	No. 54
	1 Marin Co., California	A.M.N.H.	No. 2770
	3 Yosemite National Park, California	A.M.N.H.	Nos. 51683-5
	1 Tuolumne Co., California	A.M.N.H.	No. 52219

^a The following abbreviations are used: A.M.N.H., American Museum of Natural History; U.M.M.Z., University of Michigan Museum of Zoology; C.U., Cornell University.^b These allocations are tentative, and the specimens should be re-examined when larger and more extensive series are available.

TABLE 5

MEASUREMENTS (IN MILLIMETERS) AND RATIOS FOR *Rana moorei* AND RELATED SPECIES

	Body	Head Length	Head Width	Hind Limb	Body/Head	Body/Hind Limb	Head Length/Head Width
Arroyo Sacahuite							
A.M.N.H. No. 52903	54	18.7	18.4	71.0	2.9	0.76	1.01
52904	45	17.5	17.0	67.5	2.6	0.67	1.03
52905	62	22.0	21.1	92.3	2.8	0.67	1.04
52906	48	18.2	17.7	69.2	2.6	0.69	1.03
52907	45	17.1	17.0	61.2	2.6	0.74	1.01
52908	62	24.7	22.2	95.1	2.5	0.65	1.11
52909	42	14.1	15.0	55.7	3.0	0.75	0.94
52910	56	19.7	19.8	89.5	2.8	0.63	0.99
52912	57	20.3	20.0	82.7	2.8	0.69	1.01
52913	54	18.0	19.3	84.4	3.0	0.64	0.93
52914	38	15.8	14.2	59.5	2.4	0.64	1.11
52915	38	15.0	13.7	56.1	2.5	0.68	1.09
52916	55	20.3	19.8	83.0	2.7	0.66	1.03
52917	60	22.3	21.3	93.8	2.7	0.64	1.05
52918	58	21.8	20.0	90.6	2.7	0.65	1.09
52919	49	18.0	17.4	67.4	2.7	0.73	1.03
52920	52	17.8	18.0	79.4	2.9	0.65	0.99
52921	49	17.2	16.8	71.3	2.8	0.69	1.02
52922	46	18.6	17.7	67.0	2.5	0.69	1.05
52923	49	20.5	18.4	77.5	2.4	0.63	1.11
52924	49	18.0	18.6	77.4	2.7	0.63	0.97
<i>R. tarahumaræ</i>							
A.M.N.H. No. 12533	43.3	17.1	16.8	69.2	2.5	0.63	1.01
12534	47.6	18.6	18.8	78.5	2.6	0.61	0.99
U.M.M.Z. No. 75743	97.2	33.1	35.0	159.1	2.9	0.61	0.95
75743	57.0	21.3	22.2	95.0	2.7	0.60	0.96
75744	86.5	30.1	32.9	146.5	2.9	0.59	0.91
75745	42.0	15.8	16.0	62.0	2.7	0.68	0.99
75745	43.4	14.8	16.4	65.0	2.9	0.67	0.90
75745	45.5	16.7	17.0	72.8	2.7	0.62	0.98
78339	72.3	26.3	28.3	118.0	2.7	0.61	0.93
78340	70.5	24.1	26.5	113.6	2.9	0.62	0.91
78340	59.7	20.8	22.0	92.4	2.9	0.65	0.95
78340	48.5	15.8	18.5	78.1	3.1	0.62	0.85
78341	68.2	23.7	26.1	107.2	2.9	0.64	0.91
78341	64.1	22.1	23.0	95.0	2.9	0.67	0.96
78341	59.1	21.0	21.8	90.0	2.8	0.66	0.96
78341	47.8	16.7	17.2	70.7	2.9	0.68	0.97
78341	47.8	16.0	16.8	74.5	3.0	0.64	0.95
Boulenger's <i>R. tarahumaræ</i>							
No. 1	73	25	30	125	2.9	0.58	0.83
2	77	25	29	122	3.1	0.62	0.86
3	65	21	24	104	3.1	0.62	0.87
4	58	20	23	98	2.9	0.59	0.87
5	61	21	23	103	2.9	0.59	0.91
6	45	16	17	74	2.8	0.61	0.94
<i>R. b. boylii</i>							
A.M.N.H. No. 54	38.7	14.5	16.1	74.0	2.7	0.52	0.90
2770	43.6	15.5	17.5	78.6	2.8	0.55	0.89
51683	41.6	15.0	16.0	71.8	2.8	0.58	0.94
51684	32.5	10.0	12.1	52.2	3.2	0.62	0.83
51685	32.5	10.0	12.4	52.5	3.2	0.62	0.81
52219	75.5	25.0	31.0	131.3	3.0	0.58	0.81
<i>R. pustulosa</i>							
A.M.N.H. No. 51224	74.8	25.5	27.3	121.3	2.9	0.62	0.93
52040	73.1	26.5	27.0	111.0	2.8	0.66	0.98
52041	73.8	25.8	27.9	115.0	2.8	0.64	0.92
52042	72.0	28.4	30.2	111.0	2.5	0.65	0.94
5204	77.5	29.0	31.0	122.0	2.7	0.64	0.94
5204	88.0	30.7	34.3	127.1	2.9	0.70	0.90
	70.5	27.2	29.1	113.6	2.6	0.62	0.93

	Body	Head Length	Head Width	Hind Limb	Body/Head	Body/Hind Limb	Head Length/Head Width
	66.0	24.8	28.5	105.8	2.6	0.62	0.87
	60.8	21.7	22.7	96.7	2.8	0.63	0.96
	68.3	25.6	28.9	111.1	2.7	0.61	0.89
	63.4	23.8	23.8	103.3	2.7	0.61	1.00
	58.2	22.8	23.7	94.3	2.5	0.62	0.96
	65.3	25.0	27.4	105.5	2.6	0.62	0.91
	69.1	26.8	28.2	115.6	2.6	0.60	0.95
	70.8	26.2	29.6	115.4	2.7	0.61	0.89
	57.6	22.7	23.5	92.8	2.5	0.62	0.97
	58.0	22.3	25.0	91.8	2.6	0.63	0.89
	56.3	21.6	22.3	91.5	2.6	0.61	0.97
	64.8	25.7	26.8	105.4	2.5	0.61	0.96
	67.5	25.5	29.0	110.5	2.6	0.61	0.88
<i>R. palmipes</i>							
A.M.N.H. No. 44555	105.0	40.3	41.1	154.8	2.6	0.68	0.98
44556	82.3	30.6	30.7	131.4	2.7	0.63	1.00
44557	84.1	32.0	31.3	137.0	2.6	0.61	1.02
44558	104.7	39.3	41.7	159.2	2.7	0.66	0.94
44559	89.4	33.3	34.1	139.1	2.7	0.64	0.98
44560	101.2	36.6	38.7	148.0	2.8	0.68	0.95
44561	76.0	29.2	28.6	118.4	2.6	0.64	1.02
44562	105.2	39.5	39.7	154.7	2.7	0.68	0.99
44563	85.8	30.1	31.7	130.7	2.8	0.66	0.95
44564	87.8	33.5	36.5	139.8	2.6	0.63	0.92
44565	82.6	31.7	32.8	136.1	2.6	0.61	0.97
44566	85.0	31.6	31.7	140.5	2.7	0.60	1.00
44567	109.0	38.1	41.0	157.8	2.6	0.69	0.93
44568	96.5	36.4	39.0	145.1	2.6	0.67	0.93
44569	106.0	38.6	41.8	166.4	2.7	0.64	0.92
44570	91.8	33.3	34.2	144.9	2.8	0.63	0.97
44571	100.0	35.7	37.0	158.3	2.8	0.63	0.97
44572	89.7	33.6	33.7	141.8	2.7	0.63	1.00
44573	88.2	32.2	35.0	144.8	2.7	0.61	0.92
44574	93.7	35.2	37.5	151.5	2.7	0.61	0.94
Unnumbered	74.1	28.2	29.2	120.7	2.6	0.61	0.97
	67.0	26.0	25.3	101.3	2.6	0.66	1.03
	75.3	28.5	29.2	113.7	2.6	0.66	0.98
	66.1	25.7	26.0	106.1	2.6	0.62	0.99
	77.0	28.7	30.0	121.0	2.7	0.64	0.96
	74.0	27.5	26.7	114.8	2.7	0.65	1.03
	73.1	26.5	25.0	115.5	2.8	0.63	1.06
	67.8	26.2	25.0	108.4	2.6	0.63	1.05
	77.2	29.3	30.7	124.7	2.6	0.62	0.95
	81.5	30.0	31.5	125.0	2.7	0.65	0.95
	74.9	28.0	29.6	131.0	2.7	0.57	0.95
	79.0	29.7	28.7	124.4	2.7	0.64	1.03
	72.4	28.1	28.7	120.5	2.6	0.60	0.98
	77.6	31.2	32.1	125.9	2.5	0.60	0.97
	75.0	29.0	31.0	124.4	2.6	0.60	0.94
	69.6	27.2	27.0	113.2	2.6	0.61	1.01
	70.8	26.3	25.5	107.5	2.7	0.66	1.03
	72.6	29.2	28.7	121.0	2.5	0.60	1.02
	76.1	28.3	29.0	121.2	2.7	0.63	0.98
	66.2	25.7	26.7	107.7	2.6	0.61	0.96

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A NEW GENUS AND SOME NEW SPECIES AND SUBSPECIES OF NEOTROPICAL HESPERIIDAE (LEPIDOPTERA, RHOPALOCERA)

BY ERNEST L. BELL

The insects that are described on the following pages of this paper have been received by the American Museum of Natural History from various sources, but nearly all of those from localities in Colombia are from the generous donations of Mr. Frank Johnson, as is also the one from Mexico which was in the unidentified material of the C. C. Hoffmann Collection.

All of the type material mentioned in this paper is in the collection of the American Museum of Natural History except one paratype which is noted in its place.

Where reference is made to the venation of the wings by number, it follows the English system of numbering the veins of each wing from the lowest vein upward.

***Phocides johnsoni*, new species**

Figure 1

MALE

On the upper side the ground color of both wings is black. The primaries have 10 white hyaline spots, of which five are subapical and consist of two fairly large ones in interspaces 5 and 6 and three small ones in interspaces 7, 8, and 9; three discal spots, of which one is in the cell and one each in interspaces 1 and 2, forming an oblique line towards the inner angle; two outer spots, one each in interspaces 3 and 4, midway between the discal band and the subapical spots. The basal blue rays are all well developed, the upper one extending far along the upper edge of the cell and the lower ones not quite reaching the discal band of hyaline spots. There is a short blue stripe just above the two outer hyaline spots and a series of eight small submarginal blue spots. The fringes are black.

The secondaries have five blue rays, of

which the upper one begins on vein 7 at about the basal third of that vein, the lower four rays begin from the base of the wings, and the upper one of these four rays apically merges with the next ray below it. The ray along the edge of the abdominal fold tends to become bluish white at its lower extremity. There is a submarginal band of blue spots which are interrupted in interspace 4.

On the under side the ground color of the wings is black. On the primaries the hyaline spots of the upper side are repeated. There are some blue scales at the base of the costal margin, and there is a blue spot from the costal margin across the cell into the base of interspace 2; there is a small blue stripe over the hyaline cell spot and another one over the two outer hyaline spots. The veins separating the middle spot of the hyaline discal band from the spots above and below it are also scaled with blue. There are four blue spots forming a submarginal band, the two upper ones are small and in a line with the lower hyaline subapical spot, the two lower ones are larger and in a line with hyaline spot in interspace 3. There is a short blue stripe along the upper side of vein 1, under the hyaline spot in interspace 1. Below vein 1 the ground color is paler brownish.

The secondaries have three blue bands and a blue stripe along the body and the inner margin. The inner one of the three blue bands extends somewhat curved from the base of the wings to the middle of the inner edge of the abdominal fold; the next blue band is subbasal and slants outward to vein 4; the other blue band is submarginal and it is interrupted in interspace 4. The fringes are white, crossed by black at the end of the veins.

On the upper side the head is black crossed by three narrow blue lines. The collar and the shoulder covers are black, and each has a central blue line. The tegulae are blue. The thorax and the base of the abdomen are scaled with blue; the rest of the abdomen is black with the segments narrowly edged with blue. On the under side the palpi are white; the pectus is white in the center and black on the sides; the thorax is black striped with white; the abdomen is black in the center and white on the sides. The antennae are black on both sides.

LENGTH OF ONE PRIMARY WING: 27 mm.

TYPE MATERIAL: The holotype male is from R. San Joaquin, Cauca, Colombia, 1500 meters, June, 1946 (K. von Sneidern).

This beautiful species is named for Mr. Frank Johnson.

On the upper side of the wings this species may be distinguished from other *Phocides* species having a similar superficial appearance, by the greatly developed basal blue rays of the primaries and the somewhat deeper blue color of these rays, and by the blue rays of the secondaries being all entirely blue except the lower extremity of the abdominal ray which is bluish white. In the closely allied continental species having similar rays on the secondaries, some of the rays are white or only tinged with blue.

There is some resemblance between *johnsoni* and *Phocides urania* Westwood and Hewitson from Mexico and Guatemala, but in *urania* the subapical spots of the primaries are placed somewhat differently and all of the rays and bands of both wings are green and not blue. The male genitalia of *johnsoni* are very similar to those of *urania*.

Codatractus amazonensis, new species

Figure 2

MALE

The ground color of the upper side of both wings is dark brown. The primaries have a light overscaling of fulvous in the basal area and along the inner margin. There are 10 white hyaline spots, of which three are subapical in an oblique line, the

upper two are a little elongate and the lower one is ovate; five form a discal band from near the costal margin to near the outer margin in interspace 1, the spot on the costal margin is small and quadrate, the three spots below it are larger and excised on their outer sides, the fifth spot is near the base of interspace 3 and is small and quadrate; the last two spots are in interspaces 4 and 5 below the subapical spots, and both of them are minute. In interspace 1 the fringes are sordid whitish, and above there they are brown.

The secondaries are overscaled with dull fulvous below vein 7. There is a somewhat irregular dark brown discal band and a short, indistinct, subbasal band. The fringes are a little paler than the ground color of the wings and are crossed by darker brown at the end of the veins.

On the under side of the wings the ground color is nearly as dark as on the upper side. On the primaries the ground color shades to a little paler towards the outer margin of the wings, and in this area the black veins are a little contrasted. The hyaline spots of the upper side are repeated. All of the space below vein 1 to the inner margin is pale yellowish white. Along the outer margin there is a scattered overscaling of pale yellowish which accumulates to form small, ill-defined spots at the apex of the wings and on the base of the fringes in some of the interspaces below the apex.

The secondaries are lightly overscaled with pale yellowish which accumulates to form a short, hazy, subbasal band, an ill-defined spot in the cell, and an irregular submarginal band of spots. At the anal angle there is a hazy, darker spot. The abdominal fold contains a shallow pouch extending from near the base of the fold for about one-half its length, and this pouch is lined with whitish scales and contains a brush of moderately long, orange brown, hair-like scales arranged in an oblique row, slanting outward and downward. The fringes are as on the upper side.

The upper side of the head and the body is dark brown with intermixed fulvous scales. On the under side the palpi and pectus are fulvous and brown intermixed, and there is a pale yellow spot below each

eye. The thorax is dull fulvous and brown, the abdomen is yellowish fulvous with a dark central line. The clubs of the antennae are missing, but what is left of the shafts are black on the upper side and on the under side are spotted with pale yellowish at each joint.

FEMALE

On the upper side the ground color of the wings is a little paler than that of the male, and the fulvous overscaling is a little heavier, especially on the secondaries. On the primaries there are only nine white hyaline spots, the one in interspace 5 of the male being absent, the lower subapical spot is very minute which causes it to appear to be removed well outward of the upper two, the spot near the space of interspace 3 is also very small, and the spot in interspace 4 is so small that it barely can be seen without a lens. The fringes are as in the male. The two dark bands of the secondaries are more plainly seen than in the male.

The under side of the primaries differs from that of the male only in the slightly paler ground color and in the lack of the hyaline spot in interspace 5. On the secondaries the yellow bands are more prominent, and the upper spot of the subbasal band is large and bright; there is a discal band of these spots instead of just a cell spot as in the male. The submarginal yellow band and the dark anal spot are as in the male.

The allotype female has one entire antenna which shows that the club is barely thicker than the shaft and that it curves into a long, tapering apiculus which is sharply pointed at the apex. The under side of the club and the apiculus is pale yellow.

LENGTH OF ONE PRIMARY WING: Male and female, 23 mm.

TYPE MATERIAL: The holotype male is from Leticia, Amazonas, Colombia, May, 1946 (L. Richter); the allotype female is from Rio Tapajoz, Brazil.

It is doubtful that *amazonensis* really belongs in *Codatractus*, as the primaries are more rounded on the outer margin, the antennal club is thinner and the apiculus

longer, and the brush of hairs on the under side of the abdominal fold is not possessed by the other members of the genus. However, we are disinclined to erect a monotypical genus for *amazonensis* and provisionally place it in the genus *Codatractus* where it should easily be recognized because of its close superficial resemblance to other members of the genus, especially *imalena* Butler. On the upper side of the primaries *amazonensis* may be immediately distinguished from *imalena* by the position of the hyaline spot in interspace 3. In *amazonensis* this spot is close to the base of the interspace and appears to form part of the discal band of hyaline spots, while in *imalena* the spot in interspace 3 is removed well outward and does not form part of the discal band. The maculation of the under side of the secondaries is very different in the two species, and the males of *imalena* do not have the brush of hairs in the abdominal fold.

Gorgopas viridiceps sneiderni, new subspecies

MALE

This subspecies differs from typical *viridiceps* Butler and Druce in having a heavy overscaling of grayish white on the under side of the secondaries, which varies among individuals in the extent of the area covered by these scales; in some specimens it is more than half of the lower part of these wings and in others it is a little less than half.

FEMALE

There is only one worn specimen of this sex at hand and on the upper side it is similar to the male. On the under side of the secondaries the grayish white overscaling is reduced in area; it is very heavy in the abdominal fold from where it extends to the lower part of the discal area in more or less scattered scales.

LENGTH OF ONE PRIMARY WING: Male, 18–20 mm.; female, 19 mm.

TYPE MATERIAL: All from Colombia. The holotype male is from San Jose, Cauca, 2200 meters, east side of the western Andes, June, 1946. The allotype female is from

Gallera, June-July, 1911. Paratypes: Thirty males from San Jose, Cauca, east side of the western Andes, 2200 meters, and west side of the western Andes, 1900 meters, June, 1946; R. San Joaquin, Cauca, 1500 meters, June, 1946.

All of the specimens in the type material except the allotype female were collected by Mr. K. von Sneidern for whom this subspecies is named.

The male genitalia are the same as those of typical *viridiceps*.

***Pellicia borra*, new species**

Figure 4

MALE

The upper side of both wings is deep blackish brown, and there are faint indications of the usual darker bands. The primaries have three small, white, subapical spots which are semihyaline. The secondaries have a short hair tuft from near the base of the costal margin.

The under side of the primaries is a little paler than the upper side but still very dark except along the inner margin where it is much paler. There is a faint indication of a narrow, submarginal dark line. The three subapical spots are repeated. The secondaries are paler than the primaries and have three dark brown bands; one is submarginal, one is discal, and the other is subbasal.

The upper side of the head and body is blackish brown. On the under side the palpi, the pectus, and the thorax are dark brown, the abdomen is a little paler brown. The antennae are black on both sides.

LENGTH OF ONE PRIMARY WING: 19 mm.

TYPE MATERIAL: The holotype male is from La Carmen, 1000 meters, November 30, 1945, Rio Opon region north of Tunja, Boyaca, Colombia, 06° 15' N. (L. Richter). Paratype: One male from La Barrascosa, 500-1200 meters, December 31, 1945, Rio Opon region north of Tunja, Boyaca, Colombia, 06° 15' N. (L. Richter).

This insect is another one of the very dark species of *Pellicia* of the *macarius* group which cannot be distinguished from each other except by the male genitalia.

***Pholisora lorea*, new species**

Figure 3

MALE

The upper side of both wings is brown. The primaries have hazy indications of darker marginal and submarginal bands and a dark spot in the end of the cell. There are three small, white, subapical spots, the middle one under the upper one and the lower one a little outward of the upper two. There is no costal fold. The fringes are concolorous.

The secondaries have rather indistinct darker bands; one is marginal, one is discal, and one is subbasal. The fringes are concolorous.

On the under side the color of both wings is but little paler brown than on the upper side, and there are the same indistinct, darker bands. The subapical spots of the primaries are repeated.

The upper side of the head and body is dark brown. On the under side the palpi and the pectus are dark brown with fulvous scales intermixed. The thorax is dark brown and the abdomen somewhat paler brown. The antennae are missing.

LENGTH OF ONE PRIMARY WING: 18 mm.

TYPE MATERIAL: The holotype male is from Loretoyacu, Amazonas, Colombia, March 29, 1946 (L. Richter.)

The male genitalia are quite similar to those of *Pholisora cupreiceps* Mabilie. In the latter species the top of the head, the collar, and the shoulder covers are covered with shining golden yellow scales and the male has a costal fold on the primaries, whereas in *lorea* there are no golden yellow scales on the top of the head, collar, and shoulder covers, and there is no costal fold on the primaries.

***Dalla quasca*, new species**

Figure 5

MALE

The upper side of the wings is blackish brown. Both primaries and secondaries have fulvous scales on the base. The fringes are paler rufous brown.

The primaries have seven golden fulvous semihyaline spots, of which three are sub-

apical, the lower one the larger; one is in the upper part of the cell a little before the apex; three are discal, in interspaces 1, 2, and 3, the middle one the larger.

The secondaries have a discal orange fulvous spot varying a little in shape but usually somewhat reniform.

On the under side of the primaries the costal margin and apical area are rufous; all the rest of the wings is black. The spots of the upper side are repeated and a little larger. There is a small black dot on the base of the fringes at the end of each vein.

On the under side of the secondaries the abdominal fold is blackish, and the ground color of the rest of the wings is rufous. The discal spot is repeated but it is not so brightly colored as on the upper side, being but little paler than the ground color of the wings, and in some individuals there is a hazy pale spot in the basal third of interspace 7. The discal spot is outwardly bordered by two parallel wavy brown lines which extend from the base of the wings entirely around the discal spot to the abdominal fold. The space between the two lines is sometimes completely filled in with blackish brown so that there appears to be a solid dark band; sometimes there are spots of the ground color in the center of the band and sometimes the entire space between the lines is the same as the ground color of the wings. The outer wavy line is bordered outwardly by pale spots, one in each interspace, of which the lower spot near the anal angle of the wings is the most prominent; these pale spots vary in distinctness and in some individuals are almost absent. The base of the fringes have the black dots as on the primaries.

The upper side of the head, thorax, and abdomen is fulvous and black. On the under side the palpi, pectus, and thorax are yellow fulvous with some blackish scales; the abdomen is orange fulvous. The antennae are black on the upper side, and on the under side they are spotted with fulvous at each joint; the club is pale fulvous and the apiculus is red.

FEMALE

The female is similar to the male, but the spots of the primaries and the discal

spot of the secondaries are a little paler in color.

LENGTH OF ONE PRIMARY WING: Male, 13–15 mm.; female, 14 mm.

TYPE MATERIAL: All from Colombia. The holotype male is from Usaquen, Cundinamarca, 2800–2900 meters, January 8, 1946, "subparamo de" Bogota, 04° 15' N.; the allotype female is from Quasca, January 30, 1946, Cordillera Oriental, 2900–3300 meters. Paratypes: Six males, one is from Usaquen, same data as the holotype; one is from El Chico, 3000 meters, November 20, 1945, "subparamo de" Bogota, 04° 15' N.; one is from La Soledad, 650–1500 meters December 8, 1945, Rio Opon region north of Tunja, Boyaca, 06° 15' N.; one is from La Lechera, 850 meters, February 15, 1946, Rio Opon region north of Tunja, Boyaca, 06° 15' N. (L. Richter); one is from San Jose, Cauca, west side of the western Andes, 1900 meters, June, 1946 (K. von Sneider); one is from Bogota, 1914.

This species resembles *Dalla cypselus* Felder, the type of which also came from Colombia. On the upper side of the wings there seems to be little, if anything, to separate *quasca* from *cypselus*, as they are similarly colored and the maculation varies a little in the same way in both species. On the under side of the secondaries of *cypselus* the discal spot is bright fulvous and sharply contrasts with the ground color of the wings, whereas this spot in *quasca* is either the same color as the ground or but very little paler and it does not sharply contrast. The borders of the band surrounding the discal spot of *cypselus* are not so wavy as those of *quasca*, and the band itself is solid without pale spots in the center.

The uncus of the male genitalia of *cypselus* is short with a broad bifid apex; that of *quasca* is long and tapers to a narrow bifid apex. The claspers of the two species are somewhat similar, but the termination of the lower lobe is different. The aedeagus of *quasca* has numerous short external teeth before the apex, and in *cypselus* these are absent.

Dalla quasca equatoria*, new subspecies*MALE**

This subspecies from Ecuador differs from typical *quasca* from Colombia in being a little larger. The average length of one primary wing of the males in the type series of *quasca* is approximately 13.29 mm. and that of the type series of *quasca equatoria* is approximately 14.90 mm.

On the under side of the secondaries *equatoria* also differs from typical *quasca* in the brighter and more mottled appearance of these wings due to the discal spot's being brightly colored and contrasting with the ground color of the wings; the spot in the base of interspace 7 being larger and brighter and the series of spots outwardly bordering the dark band around the discal spot are usually more developed and sometimes extend to the apical part of interspace 7.

LENGTH OF ONE PRIMARY WING: 14.50–15 mm.

TYPE MATERIAL: All from Ecuador. The holotype male is from vicinity of Banos, Rio Blanco, 1700–1900 meters, September 6, 1939. Paratypes: Twelve males, two from vicinity of Banos, Yunguilla, Rio Pastaza, 1700–1800 meters, August 4, 23, 1939; one from Chin Chin Grande, Tungurahua, 1400 meters, October, 1939; two from vicinity of Banos, Rio Blanco, 1700–1900 meters, September 6 and October 5, 1939; one from vicinity of Banos, Eltablou, 2000 meters, October 28, 1938; one from vicinity of Banos, Runtun, 2000–2500 meters, December 19, 1938; five from Ecuador without further data.

The male genitalia of *equatoria* are the same as those of typical *quasca*.

Dalla dora*, new species*Figure 6****MALE**

The upper side of the wings is blackish brown. The primaries have seven pale yellowish white hyaline spots, of which three are subapical, the middle one the smallest; one is in the upper part of the cell and is small; three are in a discal band, the middle one the largest. The fringes are brown.

The secondaries have a pale yellow, somewhat reniform discal spot. The fringes are brown, paler at the tips than at the base.

On the under side the primaries are a paler shade of brown than on the upper side and somewhat rufous along the costal margin and at the apex. The spots of the upper side are repeated, the one in interspace 1 much enlarged and confluent with the spot in interspace 2. The secondaries are rufous brown. The discal spot of the upper side is repeated and pale yellowish. There is a small, hazy, pale yellowish spot near the anal angle and some scales of the same color extending above it and forming an indistinct submarginal line.

Top of the head and the body is black with some dull fulvous scales intermixed, and when viewed in certain angles of light there is a slight greenish reflection. On the under side the palpi, pectus, and thorax are fulvous brown with some black scales intermixed; the abdomen is fulvous brown. The antennae are missing.

LENGTH OF ONE PRIMARY WING: 14 mm.

TYPE MATERIAL: The holotype male is from Zamora, Ecuador, 1000 meters, October 20, 1941.

This species is very much like *Dalla cypselus* Felder and the above described *Dalla quasca equatoria*, from both of which it differs in having much paler spots of the primaries and discal spot of the secondaries. The male genitalia of *dora* are different from those of both *cypselus* and *quasca*.

Poanes zabulon richteri*, new subspecies*MALE**

On the upper side of the wings this subspecies differs from typical *zabulon* Boisduval and LeConte in the much broader black border of the primaries and to a somewhat less extent that of the secondaries. On the primaries the fulvous area is so much reduced that in interspace 4 it is merely an isolated spot not filling the base of the interspace.

On the under side of the secondaries the usual band of dark spots in the basal area

is entirely missing or at most but faintly indicated, and the row of uneven dark spots crossing the disc from the outer angle to the abdominal fold is more developed and becomes a coherent band.

FEMALE

The females of this subspecies are not deep blackish brown as are the typical females of *zabulon* but are much like the males, the fulvous areas perhaps a shade paler. On the under side of the primaries the subapical spots are white and not yellow as in the males, and the whole apical and outer marginal areas are more broadly black. On the under side of the secondaries the abdominal fold is fulvous, and all the rest of the wings is heavily overscaled with rusty reddish, through which the fulvous discal area of the upper side dimly shows and the dark discal band appears as a narrow dark line.

LENGTH OF ONE PRIMARY WING: Male, 14–16 mm.; female, 16 mm.

TYPE MATERIAL: All from Colombia. The holotype male is from Usaquen, Cundinamarca, 2800–3000 meters, January 8, 1946, Rio Opon region north of Tunja, Boyaca, 06° 15' N. The allotype female is from Bogota, "paramo," 3000 meters, August 14, 1945 (L. Richter). Paratypes: One male from the same locality and date as the holotype; one male from the same locality as the allotype, November 14, 1945 (L. Richter); two males from Cota, near Bogota, August 28, 1938, 2600 meters, and Bogota, September 12, 1938, 10,000 feet (T. Hallinan), all in the collection of the American Museum of Natural History. One male from Bogota in the collection of Mr. Kenneth J. Hayward, Tucuman, Argentina.

The male genitalia are the same as those of typical *zabulon*.

Rhinthon sarus, new species

Figure 9

MALE

The upper side of the wings is dark brown. The primaries have long brown

hairs in the base of interspace 1. The fringes of both wings are fulvous brown, and they may or may not be feebly crossed by dark brown at the end of some of the veins.

On the under side of the primaries of the holotype there is an irregular black band extending from the base of the wings through the cell and almost to the apex of the wings; this band begins wide at the base, narrows through the cell and then widens again; the costal margin is narrowly fulvous brown as far as the end of the cell where it widens a little; the apex and the outer margin are fulvous brown crossed by black veins; the inner angle area below vein 3 is pale brown; there are three or four small subapical spots which are not present on the upper side of the wings. In the male paratype the black band is extended to the costal margin so that there is no fulvous brown in that area as there is in the holotype.

On the under side of the secondaries there is a broad subbasal black band which is produced outwardly to the outer angle; there is a pale yellowish brown spot on the upper side of vein 8 at the base of the wings, another similar spot in the base of interspace 7, and another one in the upper part of the base of the cell, and another one in the lower part of the apex of the cell. The outer half of the costal margin is pale brown, the abdominal fold is purplish brown, and the rest of the anal area of the wings is yellowish white. There is a discal band of small whitish spots in each interspace between veins 1 and 8, the upper spot the larger. In the male paratype the discal band of whitish spots is much less distinct.

The upper side of the head and thorax is dark brown with a green reflection. The collar is internally lined with red, and this shows as a narrow red line extending from behind one eye to behind the other eye. The abdomen is dark brown. On the under side the palpi, pectus, and thorax are grayish; the abdomen is pale yellow brown. The antennae are black on the upper side, with a yellow band at the base of the club; on the under side they are pale brown, and the club is bright yellowish fulvous.

FEMALE

On the upper side the female is similar to the male, but on the under side it is less brightly colored.

LENGTH OF ONE PRIMARY WING: Male and female, 16 mm.

TYPE MATERIAL: The holotype male and the allotype female are from Massaranduba-Blumenau, State of Santa Catharina, Brazil. Paratype: One male from the Itatiaya Mountains, Campo Bello, State of Rio de Janeiro, Brazil, January.

This species somewhat resembles *Rhinthon melius* Geyer in the unmarked upper side of the wings and the similar form of the maculation of the under side, but it is easily separated by the red line on the collar which *melius* lacks. The termination of the claspers of the male genitalia is a little different in the two species.

Lerodea hoffmanni, new species

Figure 10

MALE

The upper side of the wings is fuscous. The primaries have seven small yellowish spots of which three are subapical and very minute; one is in the upper part of the cell a little before the apex; three form a discal band, one each in interspaces 1, 2, and 3, the lower one is very small and indistinct. The fringes are paler brownish on the upper half of the wings and become sordid whitish at the inner angle.

The secondaries are unmarked and have sordid whitish fringes.

On the under side of the wings the ground color is paler than on the upper side. The spots of the upper side of the primaries are repeated except the one in interspace 1. The secondaries have only very faint indications of a few discal spots.

The upper side of the head and body is fuscous. On the under side the palpi, the pectus, and the body are gray. The antennae are black on the upper side, and on the under side they are spotted with whitish at each joint; the club is gray and the apiculus is red.

LENGTH OF ONE PRIMARY WING: 12 mm.

TYPE MATERIAL: The holotype male

is from Colima, Mexico, June, 1918 (C. C. Hoffmann).

This small species somewhat resembles *Lerodea labdacus* Godman but has quite different genitalia.

Vorates paramus, new species

Figure 7

MALE AND FEMALE

The upper side of the wings is dark brown, overscaled with dull pale fulvous, and with long, slightly darker fulvous scales from the base of the secondaries extending over the discal area. The primaries have one small, yellowish, semihyaline subapical spot and a discal band of four yellow spots, of which one is on vein 1 and another, just below vein 2, very small and both of them are ill defined; a long narrow semihyaline stripe in interspace 2; and a small semihyaline spot in interspace 3. There is a black stigma of three parts, the upper segment lying under the cell in interspace 2 and filling the area between the semihyaline spot and the edge of the cell, a short stripe under it in the upper part of interspace 1 and followed just below by another stripe which extends to vein 1. The fringes are paler than the ground color of the wings.

The secondaries are unmarked and have fringes as on the primaries.

On the under side of the wings the primaries are rusty brownish on the costal margin and apical area, and there is a narrow stripe of this color in the upper part of the cell; the rest of the wings is blackish. The subapical spot is present but barely visible; there are only a few yellow scales in interspace 1 which do not form a spot; the spots in interspaces 2 and 3 are present but they are paler and duller than on the upper side.

On the under side of the secondaries the abdominal fold is black, and the rest of the wings is rusty brown. There is a white stripe extending along vein 6 from the base of the wings to the outer margin. The fringes are rusty brown outwardly and a little paler at the base.

The top of the head and body is fulvous and fulvous brown intermixed. On the

under side the palpi are fulvous, the pectus and thorax are grayish fulvous, the abdomen is pale fulvous with an indistinct darker central line. The antennae are black on the upper side; on the under side they are spotted with fulvous on each joint; the club is black.

LENGTH OF ONE PRIMARY WING: Male and female, 12 mm.

TYPE MATERIAL: All from Colombia. The holotype male and the allotype female are from El Chico, 3000 meters, November 20, 1945, "subparamo de" Bogota, 04° 15' N. Paratypes: One male from Usaquen, Cundinamarca, 2800-2900 meters, January 8, 1946, Rio Opon region north of Tunja, Boyaca, 06° 15' N.; one female from Bogota, "paramo," 3000 meters, November 14, 1945 (L. Richter).

In the superficial appearance of the upper side this species resembles *Vorates decora* Herrich-Schäffer, but it is distinguished by the additional lower segment of the stigma on the primaries of the male and the longer central spot of the discal band of these wings. On the under side of the secondaries *paramus* lacks the yellow veins of *decora* and has the white stripe along vein 6 which *decora* does not have.

GENUS ZALOMES, NEW GENUS

PRIMARIES: The costal margin is very straight, being curved only a little near the base of the wings. The outer and inner margins are very straight. The apex of the wings is sharply pointed. The male has a small, black, inconspicuous stigma of three segments: the upper one is sagittate and lies in the base of interspace 2, the next one is a narrow stripe below it and lies along the under side of vein 2, the next one is a very short stripe lying on the upper side of vein 1.

SECONDARIES: These wings are elongate and extend well beyond the tip of the abdomen. The anal angle and the outer margin are evenly rounded.

The third joint of the palpi is very short and conical and almost concealed in the long vestiture of the second joint. The antennae are long, extending to a little beyond the end of the cell. The club is heavy and the apiculus is moderately long.

The hind tibiae have only one pair of spurs and some short spines.

GENOTYPE: *Zalomes colobus*, new species.

The position of this genus is near the genus *Molo* Godman, and the included species superficially resemble members of that genus. The very straight margins of the primaries and the sharply pointed apex and tripartite stigma of those wings, the differently shaped anal angle of the secondaries, and the single pair of spurs on the hind tibiae (there are two pairs in *Molo*) readily distinguish the genus *Zalomes* from the genus *Molo*.

Zalomes colobus, new species

Figure 8

MALE AND FEMALE

UPPER SIDE: The ground color of both wings is blackish brown. On the primaries the costal margin from the base of the wings to a little beyond the end of the cell is orange fulvous. There is a single orange fulvous subapical spot in interspace 6 and a discal band of orange fulvous spots extending from the inner margin to just above vein 4; the spots are irregular in size and thus both sides of the band are very uneven. The spot in interspace 2 is larger than any of the others, and this spot and the one above it in interspace 3 are semihyaline. The fringes are orange fulvous.

SECONDARIES: There is a broad orange fulvous discal band extending from the abdominal fold to vein 6. The lower side of the discal band is produced a little along the veins and it extends a little downward along the abdominal fold, thus presenting a somewhat erose appearance. The band does not reach the outer margin on vein 6 but is separated from it by a narrow band of the black ground color. There are some orange fulvous hairs in the basal part of the wings. The fringes are orange fulvous and very broad at the anal angle.

UNDER SIDE: On the primaries the semihyaline spots of the discal band in interspaces 2 and 3 are repeated, and the spot in interspace 1 appears as two spots, the lower one paler in color than the upper one, and they are not extended to the inner

margin of the wings as on the upper side. The costal margin, apical area, and the outer margin to just below vein 3 are yellowish a little suffused with fulvous brown. There are three small fulvous brown subapical spots in interspaces 6, 7, and 8 and three similar submarginal spots in interspaces 3, 4, and 5 which may have some black scales in the center. All of the rest of the wings is black. The fringes are fulvous brown.

The secondaries are yellow with a discal band of seven fulvous brown spots which extend in a curved row from near the base of the wings in interspace 7 to the abdominal fold. There is an accumulation of fulvous brown scales in the apex of the cell, but they do not form a defined spot. The abdominal fold is black and bordered on both sides by a narrow band of orange fulvous. The fringes are fulvous brown.

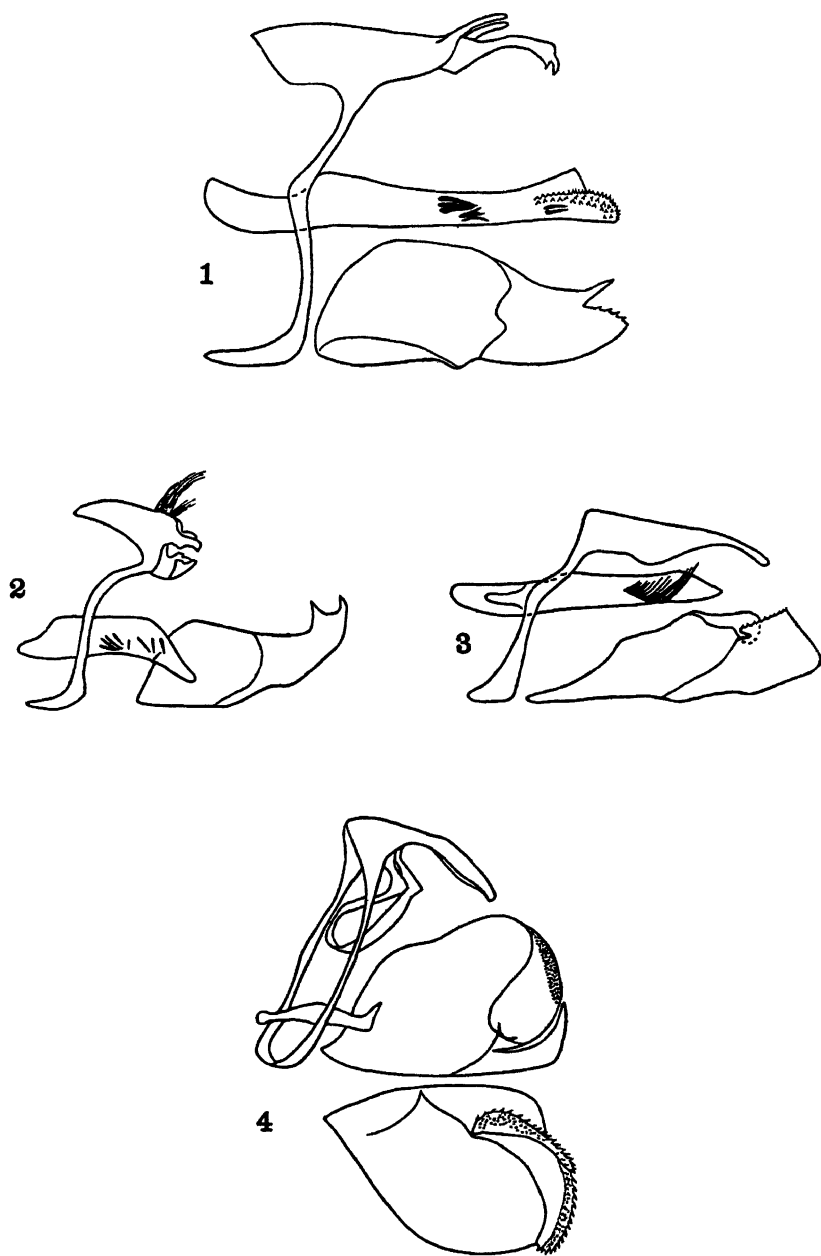
The top of the head and body is fulvous. On the under side the palpi, pectus, and thorax are yellowish; the abdomen is yellowish white. The upper side of the antennae is black with some fulvous scales intermixed; the club is black. On the under side the antennae are yellowish fulvous and the club is fulvous brown.

LENGTH OF ONE PRIMARY WING: Male, 15-16 mm.; female, 15 mm.

TYPE MATERIAL: All from Colombia. The holotype male is from Usaquen, Cundinamarca, 2800-2900 meters, January 8, 1946, "subparamo de" Bogota, 04° 15' N.; the allotype female is from Bogota, "paramo," 3000 meters, November 13, 1945. One male paratype with the same data as the holotype. All collected by Mr. L. Richter.

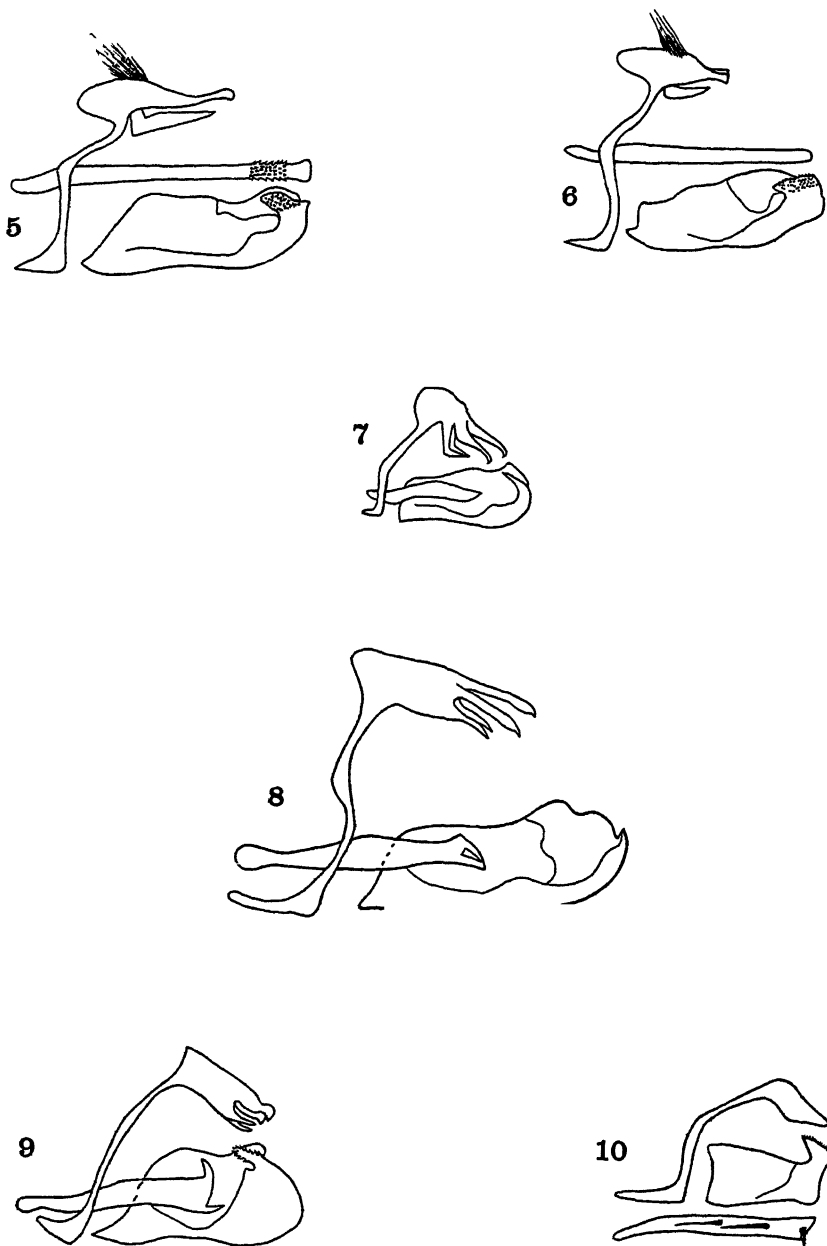
This species resembles *Zalomes conspicua* (Hayward) from Ecuador which was described in the genus *Molo*. On the upper side of the wings *conspicua* differs from *colobus* in that the discal band of the primaries is more even on its two sides and in that it is extended apically to fuse with the subapical spot, and the two spots in interspaces 2 and 3 are opaque and not semihyaline as in *colobus*. On the secondaries of *conspicua* the broad orange fulvous discal band extends to the margin of the wings at the anal angle and is not separated from the margin by a black band as it is in *colobus*.

The male genitalia of the two species are similar in form but with slight differences in detail, the most prominent being a small but well-defined tooth on the outer margin of the broad apex of the claspers of *colobus*, which is absent from the claspers of *conspicua*.



MALE GENITALIA OF HESPERIIDAE

- Fig. 1. *Phocides johnsoni*, new species.
Fig. 2. *Codatractus amazonensis*, new species.
Fig. 3. *Pholisora lorea*, new species.
Fig. 4. *Pulicia borra*, new species.



MALE GENITALIA OF HESPERIIDAE

- Fig. 5. *Dalla quasca*, new species.
Fig. 6. *Dalla dora*, new species.
Fig. 7. *Vorates paramus*, new species.
Fig. 8. *Zalomes colobus*, new species.
Fig. 9. *Rhithon sarus*, new species.
Fig. 10. *Lerodea hoffmanni*, new species.

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RESULTS OF THE ARCHBOLD EXPEDITIONS. NO. 57

A FIELD STUDY OF HOMING IN THE CAROLINA TOAD

BY CHARLES M. BOGERT

INTRODUCTION

Laboratory experiments have demonstrated that frogs, toads, and salamanders are able to learn how to find their way through mazes (Yerkes, 1903; Buytendijk, 1918). Breder (1925) found that males of a Panamanian tree frog returned on successive nights to the mud basins constructed to care for the eggs, and many other field observations indicate that both frogs and toads, in contrast to most salamanders, return to accustomed places of hiding after nocturnal foraging. McAtee (1921) reports that a bullfrog, when carried a quarter of a mile over land, returned to the home site. The earliest efforts to carry out homing experiments with frogs and toads under field conditions appear to be those of Franz (1927) in Europe and those of Breder, Breder, and Redmond (1927) in New York and New Jersey. More recently Nichols (1937) has reported preliminary studies of the movements of toads, mostly *Bufo woodhousii fowleri*, in eastern United States, and Raney (1940) has included some data on homing in the bullfrog in his account of the normal summer movements of the species, observed at Rensselaerville, New York.

The two experiments described below were carried out with the Carolina toad, *Bufo t. terrestris* (fig. 1), at the Archbold

Biological Station in central Florida. Approximately a dozen species of tailless amphibians were observed in the vicinity of the Station, but the Carolina toad, because of its relative abundance and the ease with which it could be seen and caught, was selected for the work. The property on which the Station is located has been mapped in considerable detail; hence it was a simple matter to record with accuracy the points of release.

Various means of marking frogs for future identification have been devised. Breder, Breder, and Redmond (*supra cit.*) used waterproof paper tags attached around the waist with string. Numbers on the tags could often be read without disturbing the amphibians. Raney (*supra cit.*) found the jaw tag method to be entirely satisfactory, and he believes that the use of metal tags is superior to other methods of tagging, especially for long-term studies. Because our investigations were undertaken when an opportunity fortuitously arose, no tags were immediately available. Consequently the toe clipping method was used. This requires time, patience, and considerable care, and there are other minor disadvantages. However, the technique was found to be adequate for the work.

REGION AND TERRAIN

The Archbold Biological Station is located in the middle of the peninsula of Florida, approximately 7 miles south of the town of Lake Placid in Highlands County. Red Hill, which rises to an elevation of

222.2 feet above sea level at the eastern edge of the Station property, marks the southern limit of the Highlands Ridge of central Florida. More than a square mile of land, mostly covered with scrub forest,

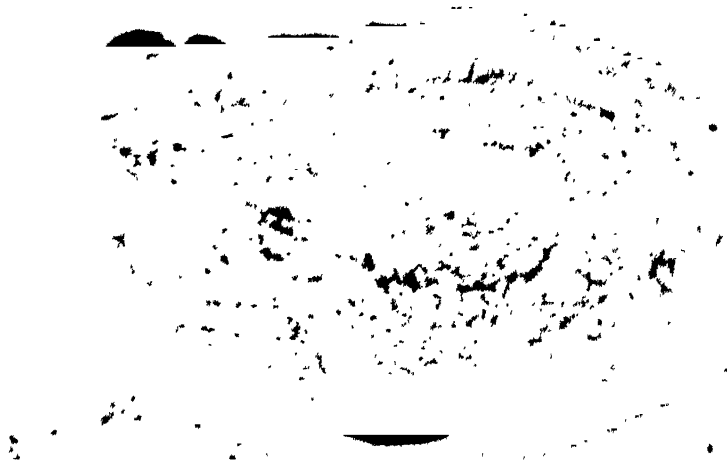
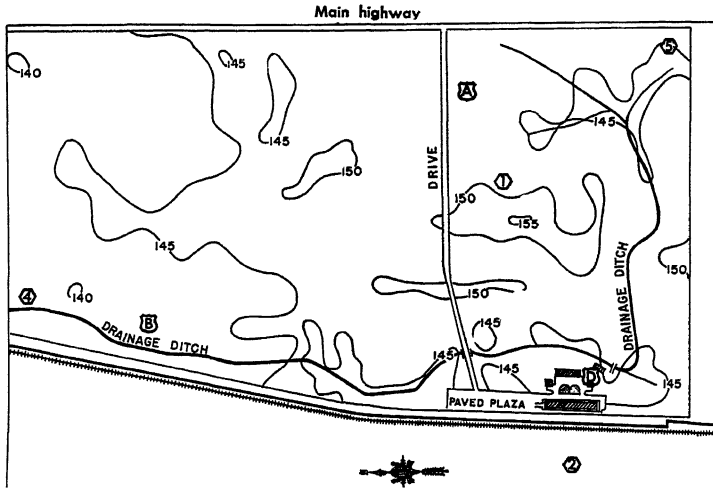


Fig. 1. The Carolina toad, *Bufo terrestris terrestris* (Bonnaterre), an adult female 90 mm. in body length. The knobs at the rear of the cranial crests are most prominent in large females, less so in males, and absent from juveniles; hence the size of the knobs appears to be dependent upon growth factors. This toad, the one used in experiments, ranges throughout Florida and, on the coastal plain, northward to southeastern Virginia, and westward to Louisiana and Arkansas. Along the northern limit of its range it intergrades with *Bufo terrestris americanus*.

has been maintained in semi-virgin condition for a number of years, although a highway traverses the scrub, and a drainage ditch has been dug, as indicated on the accompanying map (fig. 2). The buildings housing laboratories and personnel are all located on the western side of the property in the vicinity of a large paved plaza, approximately 70 yards wide and 100 yards long. West of the Station a small drainage ditch separates the main buildings from railroad tracks, and beyond the tracks the land, virtually denuded of the forest cover by lumbering operations and burned over annually when the grass is dry, is sparsely covered with patches of scrub palmetto with vestiges of small hardwood hammocks, and occasional shallow ponds. This land is relatively flat, although there is a gentle slope toward the Station so that the runoff from the ground

flows toward the Station. Water collects in pools after heavy rains (see figs. 3 and 4) and flows under the railroad tracks via culverts to the drainage ditch that in turn carries the water northward into a small pond known as Lake Annie. Photographs (figs. 5 to 7) taken from the top of a large water tower a few yards east of the plaza depict the land and the plaza where toads were collected and released.

The terrain throughout the region is sandy, and the water level during the rainy season is not far below the surface. Drainage ditches near the lower levels on the land owned by the Station contain running water almost constantly. The ditch between the railroad tracks and the Station is relatively shallow since only the plants, mostly grasses and weeds, that grow in it prevent the sides from caving. The drainage ditch on the east side of the plaza is



TIMBER NOW REMOVED, WITH
ONLY OCCASIONAL TREES LEFT.
TERRAIN MOSTLY COVERED WITH
PALMETTO

MAP SHOWING PLACE OF CAPTURE AND POINTS OF RELEASE OF TOADS USED IN EXPERIMENTS

SOUTHWESTERN PORTION OF THE LAND OWNED BY THE ARCHBOLD BIOLOGICAL STATION, IN HIGH-
LANDS COUNTY, CENTRAL FLORIDA. THE TOADS USED IN EXPERIMENTS WERE TAKEN IN THE
PAVED PLAZA AND THE IMMEDIATE VICINITY. LOCALITIES INDICATED BY NUMBERS REPRESENT
POINTS WHERE TOADS WERE RELEASED IN MAY AND JUNE, THOSE INDICATED BY LETTERS
REPRESENT POINTS OF RELEASE IN AUGUST AND SEPTEMBER.

SCALE IN YARDS
0 100 200 300

Fig. 2. Map of the region where experiments were conducted. The area with contours shown is part of the semi-*virgin* area included in the Archbold Biological Station property, and inhabited by *Bufo t. terrestris*. The area (without contours shown) to the west of the drainage ditch and the railroad tracks has been cleared, with virtually all of the timber removed. Smaller plants are burned annually, and the region did not appear to be inhabited by *B. t. terrestris*, although temporary pools immediately west of the Station were used as breeding sites.

4 or 5 feet deep, more nearly V-shaped in cross section, and faced with porous bricks. There are bridges at infrequent intervals (see map), a fact of some interest because toads released east of the plaza presumably found it necessary to cross the deeper drainage ditch in order to return. Not far south of the plaza there is a small truck garden, and after rains toads were par-

ticularly abundant along the road immediately west of it. Three houses in the vicinity of the garden, with small poultry yards, lawns, and water hydrants, seemingly make that portion of the premises a suitable haven for numbers of toads; over half of those used in experiments were taken at this end of the area wherein toads were collected.

RAINFALL

The mean annual rainfall for Highlands County has been recorded by the United States Weather Bureau 25 miles north of the Station at Avon Park, as 52.12 inches. Means for each month are reported (Kincer, 1941, p. 809) as follows:

January	2.18 inches
February	2.49
March	2.25
April	2.56
May	4.58
June	8.12
July	8.06
August	7.60
September	6.78
October	3.97
November	1.70
December	1.83

However, the precipitation at the Archbold Biological Station is not likely to be identical with that at Avon Park. Moreover, the rainfall fluctuates from year to year. Because the activities of toads are governed to a large extent by the availability of surface moisture it is pertinent to record here the daily rainfall during the period between May 26 and September 14, 1944, when experiments were in progress. The following data (table 1) were recorded by the Station on a standard rain gauge located at the edge of the plaza.

Air temperatures with both wet and dry bulb thermometers were recorded at the Station with a Bristol recorder, but their bearing on the movements of toads was of importance only under extreme conditions. Therefore detailed data have been omitted. Moisture is constantly being lost through the skin, cooling the toad to such an extent that its temperature is approximately 2° C. above that of a wet bulb thermometer when the relative humidity is much below 100 per cent. Hence the body temperature of

TABLE 1

RAINFALL AT ARCHBOLD BIOLOGICAL STATION, RED HILL, HIGHLANDS COUNTY, FLORIDA, 1944
(In inches previous 24 hours.)

Date	May	June	July	Aug.	Sept.
1		—	.10	.05	.04
2		—	.13	—	—
3		—	.19	.49	—
4		—	—	.04	—
5		—	—	.51	—
6		.10	—	—	.04
7		.52	—	—	—
8	.11	3.15	—	—	—
9	—	.27	—	—	.57
10	—	1.55	—	.17	.28
11	—	.92	.43	.50	.07
12	—	.38	.40	—	—
13	—	.02	—	.44	—
14	—	.13	—	—	—
15	—	—	—	.59	—
16	.84	—	—	—	—
17	—	.02	.025	1.01	—
18	.10	—	—	—	—
19	.52	—	.35	.20	—
20	—	—	.03	—	—
21	—	1.35	.60	.39	—
22	—	—	.51	.40	—
23	—	—	.01	.05	—
24	—	—	.05	.85	—
25	1.09	—	.45	—	—
26	—	—	.44	—	—
27	—	.17	.04	.34	—
28	—	—	.18	2.39	—
29	—	—	.80	.83	—
30	—	.12	.02	5.03	—
31	.01	—	.14	.04	—

a toad is partly dependent upon the humidity, but it will suffice to say that nocturnal temperatures recorded on the wet bulb thermometer were well within the limits of the activity range of toads throughout the experiment. *Bufo t. terrestris* was breeding whenever suitable rains occurred during the time that the experiments were in progress, and one or more individuals were abroad every night in the area where the toads used were captured.

METHODS

Other investigators have usually attempted to record more or less precisely where individual frogs or toads were found prior to being marked and carried elsewhere for release. In the experiments described herein toads were collected only within a limited area and no attempt was made to note the exact spot where each was first seen. The area chosen was that encompassed by the paved plaza and the adjacent buildings at the Archbold Biological Station. All individuals marked and released were taken within an area approximately 400 yards long and 100 yards wide (see map, fig. 2).

Because toads are essentially nocturnal in their activities all collecting was done between dusk and midnight, usually between the hours of 8:00 P.M. and 1:00 A.M. As far as possible the identical route around the periphery of the plaza was covered twice each evening. Toads were most often encountered in the open, along roads, on lawns, or on the paved plaza where they were easily seen when the beam of a five-celled flashlight strapped on the forehead was directed toward them. Often the "eye-shine" would disclose a toad at distances of 50 feet or more. When first captured toads were dropped into a wet cotton sack. At the conclusion of the evening's collecting they were carried to a large wooden sink in the laboratory where they were retained until they could be marked and released. Sometimes it was necessary to wait as long as four days before a sufficiently large lot could be assembled to make it worth while to release them.

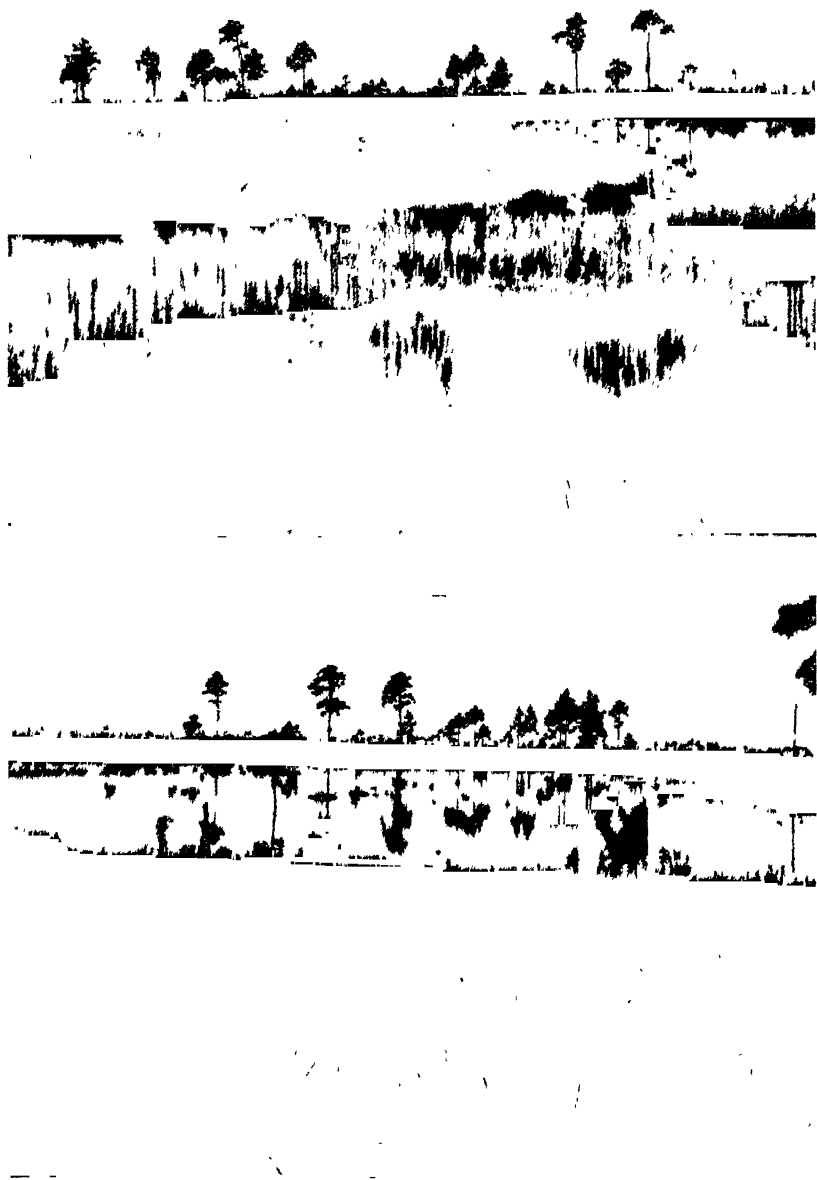
Marking for future identification was accomplished by excising toes, as noted above. Digits were clipped with a pair of scissors, from one to three being removed as close to the base as possible, without cutting the web of the hind feet. No more than one toe was removed from any foot. Serious discomfort to the toads was not manifest as a result of the wounds; the specimens with clipped toes were apparently as normal in behavior as those not marked. On specimens retaken a few days after release, the wound had nearly healed

and those recaptured after two months were readily identified even though in a few instances there was partial regeneration of digits. Under a dissecting microscope with light transmitted from below, it was easy to detect excised toes even when partial regeneration had occurred because bone was not present in the regenerated portion.

Extra digits occurred on two of the 444 toads marked, but none lacking toes was discovered prior to the date when toads with excised digits had been liberated. Two toads of the first 200 captured lacked one fore limb, and these were rejected for use in experiments. Few serious abnormalities or deformities were noted except for one specimen that lacked a functional eye on the right side, apparently as a result of injury.

When a sufficiently large number of toads had accumulated, digits were excised in various combinations. Because there are but four toes on the front feet, the toes on the hind feet were used for digits in the numbering system that was devised in advance in order to avoid any possibility of duplicating numbers. With this system and the series used it was not necessary to clip more than one toe on each limb. For example, the last toad marked in a series numbered consecutively was No. 250; on this one the left front foot had the fourth toe removed, the third toe was removed from the right hind foot, and the fifth toe was cut from the left hind foot.

Although relatively few toads were seen killed by automobiles on the highway traversing the property, no toads were liberated east of this road, in an effort to eliminate one hazard to which toads might be subject. Little is known concerning the mortality rate of adult toads. Highway casualties are those most frequently seen, but aside from man there are doubtless many other enemies. Ophidian enemies of toads include the hog-nosed snake (*Heterodon contortrix*) and the indigo snake (*Drymarchon corais*), neither of which was at all common in the area where experiments were conducted. To what extent the local mammals and birds prey upon



Figs 3 and 4 Temporary pools west of the Archbold Biological Station formed late in the season and utilized as a breeding site by *Bufo t. terrestris*

toads one can only guess. Probably a few of the toads marked and liberated never survived even though only healthy toads between the sizes of 38 mm. and 90 mm.

in body length were liberated. The vast majority of these were males; scarcely 25 per cent were females in the samples in which the sex was recorded.

FIRST EXPERIMENT

PURPOSE: The work was undertaken with the hope that answers or partial answers could be obtained for some of the questions involved in homing in toads. For examples: Is it easier for a toad to find its way home when released at a distance of 100 yards than it is for a toad to return when released a mile from the home site? In other words, aside from the hazards that beset normal travel, is there a negative correlation between the distance a toad is removed and the number of chances it has of returning? Does a toad liberated in an unsuitable habitat return to the home site as readily as one liberated in a habitat that is suitable for the species? Finally, what is the maximum distance that a toad is capable of traversing in order to return? These are the principal questions for which answers were sought.

PROCEDURE: Because toads are most active during or immediately after rains they can be taken in large numbers only at infrequent intervals. Thus it was impractical to release toads at regular intervals or in lots of similar sizes. Until the afternoon of May 25, following a storm that brought 1.09 inches of rain (see table 1), relatively few toads were seen. After this storm 19 specimens were taken. These were marked as described above and liberated the following evening at a distance of 450 yards east of the plaza, in an area with dense vegetation where toads of the same species were present but not abundant. The next lot, comprising only 13 toads, was liberated on May 29 at a distance of 100 yards from the plaza. The point of release was in the cleared area west of the Station where no *Bufo t. terrestris* had been seen previously. On the evening of June 1 a slightly larger lot composed of 15 individuals was liberated in the same direction, in the same sort of terrain, at a distance of 300 yards. A slight rain on May 31 (.01 inch) brought forth a few more toads

than it was possible to secure during the dry interval between May 28 and May 30, and 18 toads were available on June 1. These were liberated at a distance of 850 yards to the north at the edge of the Station property, and not far from a small pond where toads of the same species were moderately abundant. No rain occurred after this lot had been liberated until June 6 when 0.10 inch of rain fell, and the following day there was a second storm that brought 0.52 inch. Toads were abundant in the plaza on these nights, particularly on the second night, and 92 individuals, including five that had been recaptured, were liberated on the night of June 8 at a distance of 750 yards to the east of the plaza, at a point near the head of one branch of the drainage ditch, but at the same elevation as the plaza. *Bufo terrestris* had been seen previously, at the place of liberation, and a fair population was known to exist immediately to the south beyond the Biological Station property where a farm house and gardens were located. A storm on the night of June 8 produced a heavy rainfall, 3.15 inches, but toads were not quite so abundant as they had been the previous night, possibly because many that were active the two preceding nights had been removed. However, 43 individuals were secured, and after they had been marked the following day they were taken to a point 1 mile west of the plaza and liberated late in the afternoon.

The data for the six lots of toads liberated are shown in table 2. In summary, three lots of toads were liberated at distances of 100, 300, and 1760 yards west of the plaza in the timbered area that is burned over annually; since toads of this species were never encountered far beyond the drainage ditch, the area presumably represents an unsuitable habitat for *Bufo t. terrestris*. One lot of toads was liberated to the north at a distance of 850 yards, and



Fig 5 View from top of water tower, showing the southwest corner of the property owned by the Archbold Biological Station, and portions of cleared area west of the railroad tracks. The majority of the toads used in experiments were taken in the area in the center of the picture.

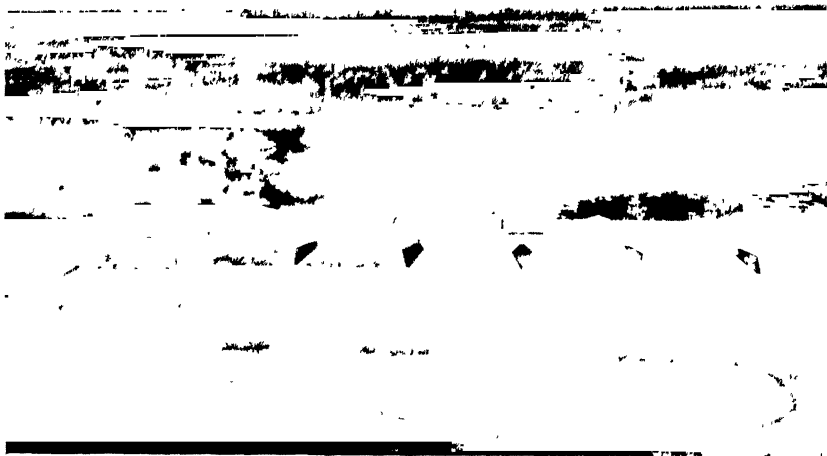


Fig 6 View from the water tower to the west, with the buildings of the Archbold Biological Station in the foreground. The pool at the left was the principal breeding site for the toads used in experiments. Toads in Lot 6 were liberated 1 mile west of the buildings in the cleared area.

two lots were turned loose respectively 450 and 750 yards east of the plaza, in all cases in places where toads of the same species occurred.

Following the release of the first lot of toads on the evening of May 26, a search of the plaza was made every night until June 15 when the work was interrupted. No toads were taken again until the evening of August 15 when work was resumed. Between the dates of August 15 and September 14, after the two month lapse, all toads that could be located in the plaza and the immediate vicinity were captured, and a record was kept of all marked, as well as of unmarked, individuals that were taken.

RESULTS: Of 200 toads marked and liberated at various distances from the plaza, a total of 53, or 26.5 per cent, were subsequently retaken. Of the 53 only 20, or 10 per cent of the total, were recovered during the first stage of the experiment in May and June. The other 33 individuals were all taken at the home site when collecting was resumed after a lapse of two months. No fewer than 20 of the 33 were taken on a single night, August 28, after 2.39 inches of rain; on the afternoon of that day 196 toads were located in or near the plaza, and 21 of the 196 were marked toads that had been liberated in May and June.

Of the two lots liberated east of the plaza, 36.8 per cent of those liberated at a distance of 450 yards were recovered in the plaza, but only 20.6 per cent of the lot removed 750 yards were seen again at the home site. Of the lot taken 850 yards to the north, 16.6 per cent were recovered. Nearly 54 per cent of 13 toads taken 100 yards to the west were retaken, 60 per cent of a second lot taken 300 yards to the west were later found in the plaza, but of 43 taken to a point of liberation a mile from the plaza only 18.6 per cent are known to have returned to the home site.

One toad taken 300 yards to the west and one toad liberated 850 yards to the north were back at the plaza the evening of the day following their release. The maximum time intervening between release and recapture was recorded for two taken after

being released 96 and 97 days, respectively. These data are summarized in table 2, along with other pertinent information, and the exact place where each of the six lots (indicated by number) in this table were liberated is shown on the accompanying map (fig. 2).

CONCLUSIONS: The data presented above are not sufficiently extensive for entirely satisfactory conclusions to be drawn. Because only six lots of toads were liberated in three directions the data are inadequate for extended statistical treatment. Moreover, it is difficult to evaluate the effects of changes in the weather. The activities of toads are governed to a large extent by the rainfall. As may be seen in table 3 below, wherein the number of toads taken over a period of two weeks is plotted separately for each night and the rainfall is indicated in the adjacent column, the numbers of toads seen in the same area in the course of several evenings are correlated with the rainfall the previous 24 hours, although the effects of a heavy rain may persist for two or three days. Additional data not included in table 3 will serve to explain the total recorded for September 1. On the night of August 28 a total of 196 toads, the maximum number taken on a single evening, was obtained in the plaza and the immediate vicinity after 2.39 inches of rain had fallen during the day. The storm was almost continuous, and notwithstanding the removal of 196 toads, 34 were taken the next night after 0.83 inch, 25 toads were taken on the night of August 30 after 5.03 inches of rain, and 23 on August 31 following 0.04 inch. The reduction in numbers on August 31, despite the heavy rainfall, is undoubtedly due largely to the quantity of toads removed from the area on the two previous nights. But on September 1, when there was only a trace of rain, 15 toads were taken, 10 of which were individuals not previously seen. Beginning on September 1 there was a steady decline in the numbers of toads seen on successive nights until September 6 when there was an abrupt increase following 0.04 inch of rain. After a decline in numbers during two days when only a trace of rain fell, there was a sharp increase on Sep-



Fig 7 View from the water tower to the northwest, showing the line of demarcation between the Archbold Biological Station and the cleared area to the west. The body of water near the horizon in the upper right-hand corner is Lake Childs

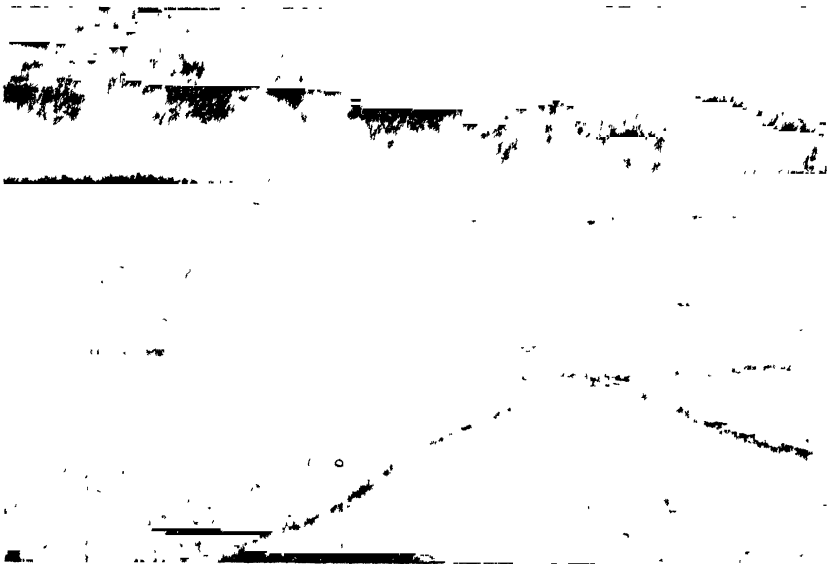


Fig 8. View from the water tower to the east, with semi-vegetated area in the foreground, orange groves at the upper right, and Red Hill at the upper left. Red Hill marks the southern end of the Highlands Ridge of central Florida

tember 9 when 11 toads were captured after 0.57 inch of rain. These figures provide only a rough approximation inasmuch as the local population was fluctuating in numbers owing to collections made every night as well as to the return after August 31 of many of the 244 toads removed from the home site. Also the figures in column E of table 3 include only toads not previously seen. These data do make it plain that toads are abroad in greater numbers during and immediately after periods of precipitation.

Evaluation of homing data is complicated by weather factors to the extent that we do not know whether a toad often attempts to travel long distances on dry evenings. And if a toad does not try to return to the home site immediately after its release, what is the effect of its being

hand one toad released 300 yards to the west, and one toad taken 850 yards to the north were each back in the plaza the night following their release. It is particularly noteworthy that the individual that traveled 850 yards within 24 hours did so on a night (June 6) when there was a fair amount of rain, 0.52 inch being recorded for the previous 25 hours the next evening. The only toad that reappeared in the plaza within 24 hours after release during a dry interval was one removed only 300 yards to the west. It is of some interest to ascertain how rapidly an adult toad can travel, and 850 yards in 24 hours is the maximum that can be proved with the data secured at the Archbold Biological Station. Aside from this information the data tabulated in the right-hand column of table 2 are of incidental interest,

TABLE 2
SUMMARY OF DATA FOR TOADS RELEASED IN MAY AND JUNE, 1944

Lot	Number Released	Date	Distance Removed	Direction	Time in Days,		
					Recoveries No.	Per Cent	Release to Capture
1	19	5/26	450 yds.	East	7	36.8	9 to 93
2	13	5/29	100 yds.	West	7	53.8	2 to 86
3	15	6/1	300 yds.	West	9	60.0	1 to 88
4	18	6/6	850 yds.	North	3	16.6	1 to 84
5	92	6/8	750 yds.	East	19	20.6	6 to 96
6	43	6/9	1760 yds.	West	8	18.6	80 to 97
Totals: 200 released					53	(26.5%) recovered	

prevented from heading homeward? Does it always find suitable shelter, and if it is delayed in its departure for home does the delay diminish any original stimulus or interfere with the toad's ability to return? These are questions that cannot be answered at present, and yet they have some bearing on the interpretation of the data presented above.

A few toads were discovered in and around the plaza every evening, but some of these had access to water from lawn sprinklers, dripping spigots, or other domestic sources. Following the liberation of the first lot of toads on May 26 there was no rain until May 31, and no heavy rain until June 7. One toad was discovered in the plaza on June 4, nine days after being released. It cannot be assumed, of course, that this toad was found the night of its arrival. On the other

and for this reason only the maximum and minimum number of days that elapsed between release and recovery are recorded.

Even though it was demonstrated that an adult *Bufo t. terrestris* can travel 850 yards in 24 hours (and probably in less time since the species was not active during the day), it is not known whether the toads that succeed in returning home do so by the most direct route, unless fortuitously, or whether most of them wander about before heading in the proper direction. Time is undoubtedly a factor of some importance in homing experiments with toads, but the 200 toads released in May and June should have had ample opportunity to return to the home site during the three-month period that elapsed between their release and the last day when a search of the plaza could be made. Although those released on May 26 were provided with more time

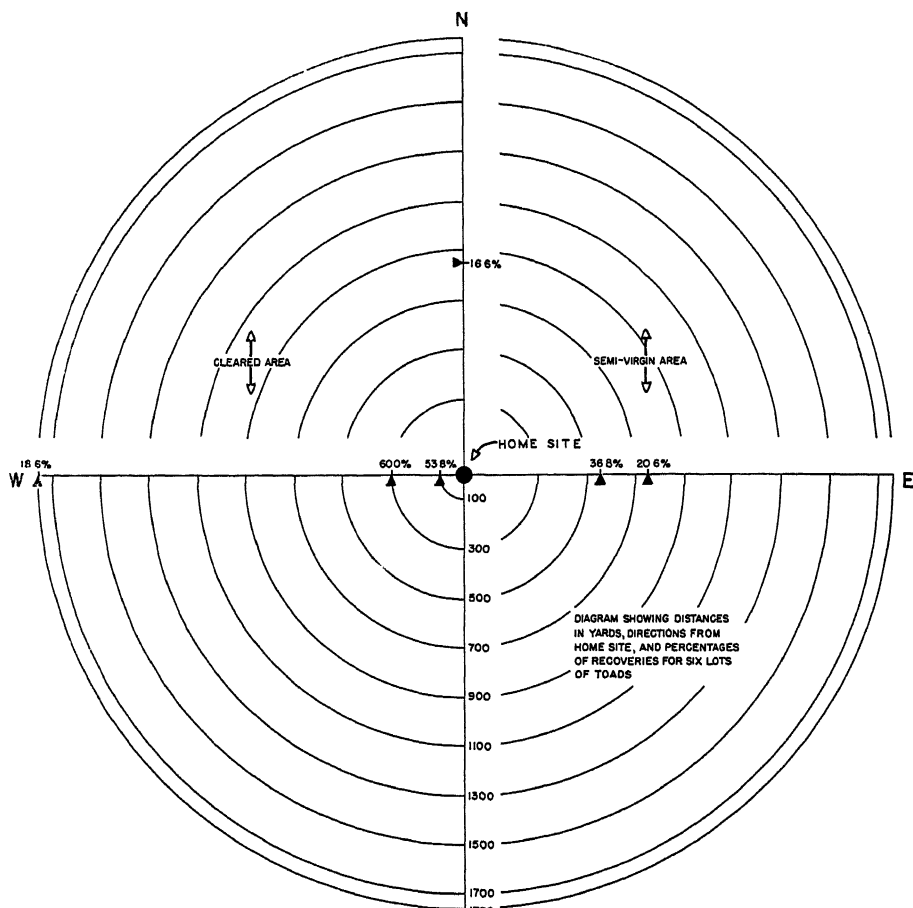


Fig. 9. Diagram showing percentages of recoveries obtained in first experiment. The area west of the vertical line represents the cleared territory that appeared to be uninhabited by *Bufo t. terrestris*; the vertical line represents the edge of the Archbold Biological Station property, and the entire area east of the line is in a semi-virgin state and inhabited by *B. t. terrestris*.

than those liberated on June 9, the results obtained for individual lots can be compared with some assurance that the percentages of each lot represent comparable, if not entirely accurate, samples of the toads in each lot that actually returned to the home site.

Because the individual groups of toads marked and liberated were taken from the home site in three main directions and liberated in different sorts of habitat, data from table 2 have been plotted in a diagram (fig. 9) for clarification. In this diagram it may be noted that the percentages of toads recaptured from two lots released to

the east of the plaza indicate that nearly twice as many toads managed to return from a distance of 450 yards as returned from a distance of 750 yards. Still fewer toads were recovered from a third lot released in the same sort of habitat 850 yards to the north. Of the toads released to the west, in an unsuitable habitat, a somewhat larger percentage of the lot released at a distance of 300 yards were recovered than in the lot released at 100 yards, in each case over 50 per cent. However, of the lot released a mile away in the same direction, only 18.6 per cent were subsequently seen in the plaza. The data are

comparable only when lots released in similar habitats are considered. Under these conditions a negative correlation exists between the distance a toad is removed and the toad's chances of returning. Inasmuch as nearly one-fifth of the toads removed 1 mile from the home site were recovered, it is plain that under favorable circumstances toads can return from distances exceeding a mile.

It is also evident that the nature of the terrain or the suitability of the habitat may have some bearing on the toad's homing ability. Only 16.6 per cent of the toads taken 850 yards to the north and only 20.6 per cent of those taken 750 yards to the east were recovered, whereas nearly the same percentage (18.6) was recovered from the lot taken 1760 yards to the west. The localities of release to the north and to the

east were known to be inhabited by, and hence represented suitable habitats for, *Bufo t. terrestris*; the area west of the Biological Station evidently was not a suitable habitat for *terrestris*. Thus, proportionately fewer toads returned from the suitable habitat than returned from the unsuitable one, but it cannot be stated whether the absence of dense vegetation in the cleared area made it easier for toads to find their way home from the west, or whether new territory was simply adopted by the toads liberated in the east. Nor is it possible to evaluate the relative importance of predators in the two types of terrain. Conceivably enemies of toads are more abundant in the places frequented by these salientians, but predation is probably a minor factor in this sort of experiment.

SECOND EXPERIMENT

PURPOSE: There is no satisfactory means of determining precisely how many toads return to the home site, because it is manifestly impossible to locate every individual that succeeds in returning. For this reason it is desirable to devise some method of estimating the total number of returns. This can be done, in theory at least, by introducing a control group. By marking a number of toads and liberating them at the home site it is possible to calculate the total number of individuals in a given area (see Dice, 1941, for a discussion of methods employed by mammalogists). The ratio of the number of recoveries to the total number released should be the same as the ratio of the number released to the total population. This involves a second assumption, based on evidence cited below, that toads released where taken tend to remain in the vicinity. Application of the same reasoning makes it possible to estimate the number of toads that return by comparing the percentages of recoveries in a lot liberated at the home site with the percentages of lots liberated away from home. The purpose of the second experiment, therefore, was to gain some estimate of the actual number of toads that returned

when lots of similar size were liberated in three cardinal directions.

PROCEDURE: Heavy rains during the latter part of August (see table 1) made it possible to assemble a large number of toads in the plaza. Within three days, August 28, 29, and 30, a total of 244 individuals were taken. This assemblage was divided into four lots, each comprising 61 individuals. For convenience in tabulating the results and in mapping the points of release (fig. 2) these lots are designated with capital letters. To permit ready identification all toads in each lot were given the same mark, instead of individual marks for each toad, as in the previous experiment.

Late in the afternoon on August 31 three of the individual lots were taken to points of release 700 yards from the plaza. (See table 3.) Those in Lot A were liberated 700 yards east of the plaza in pine flatwoods. The same number of toads, in Lot B, were carried to a point of release 700 yards north of the plaza on the edge of the semi-virgin pine flatwoods, immediately to the east of the burned-over area. Those in Lot C were taken 700 yards west of the plaza, into the burned-over area. The toads comprising Lot D were liberated

at the eastern edge of the plaza near the center of the area considered to be the home site. All toads were carried in wet sacks to the four points of release within an hour's time, those in Lot D being liberated last. Each lot comprised not only the same number of toads, but each was of approximately the same composition, those in each lot being selected at random from the 244 toads on hand.

Beginning on the night of September 1, for a two-week period terminating on the

given a special mark of identification. This was done in order to avoid counting them on subsequent nights when they were found again. Thus in table 3, column E labeled "Unmarked" includes only the "new" toads found on successive nights. The number of toads recovered from each of the marked lots was similarly recorded.

RESULTS: Toads from each of the four lots liberated on the afternoon of August 31 were recovered on the evening of September 1; one had returned from the east,

TABLE 3
SEPTEMBER EXPERIMENT.
FOUR LOTS OF TOADS, EACH COMPOSED OF 61 INDIVIDUALS
MARKED AND RELEASED ON EVENING OF AUGUST 31, AS FOLLOWS:
Lot A 700 yards east of plaza in pine flatwoods
Lot B 700 yards north of plaza at edge of pine flatwoods
Lot C 700 yards west of plaza in cleared area
Lot D, control group, in plaza at site of capture
(Column E lists unmarked specimens not taken previously)

Date in September	Toads Taken in Plaza Following Release						Rainfall
	A From the East	B From the North	C From the West	D Released in Plaza	E Unmarked	Totals	
1	1	2	1	1	10	15	Trace
2	1	2	0	3	4	10	None
3	0	0	0	2	3	5	None
4	0	0	0	0	4	4	None
5	0	0	0	0	1	1	Trace
6	2	0	1	1	2	6	04 in.
7	0	0	0	0	2	2	None
8	0	0	0	0	1	1	Trace
9	0	1	1	1	8	11	.57 in.
10	0	1	0	1	3	5	28 in.
11	0	0	0	1	8	9	07 in.
12	1	0	0	0	3	4	None
13	0	0	1	0	4	5	None
14	0	0	0	0	3	3	None
Totals	5	6	4	10	56	81	

night of September 14, a search of the plaza was conducted every evening. As in the previous experiment, a regular route reaching all portions of the area where collecting had been done in and around the plaza was covered twice each evening between the hours of dusk and midnight. All toads seen were examined, but only those in the four lots liberated on August 31 were collected. Unmarked toads, that is, toads not previously seen in or around the plaza, were collected and liberated where they were taken, immediately after they had been

two from the north, and one from the west, whereas only one of the 61 individuals liberated at the home site was recovered. There was a slight rain, officially a "trace" that night, and 10 unmarked toads were found. On the following night, when there was no rain at all, one toad from the east, two more from the north, and three from the lot released at the home site were recovered; 10 unmarked toads were seen. The data for the two-week period are summarized in table 3 wherein it may be observed that by midnight on the four-

teenth day five toads from the east, six from the north, four from the west, and 10 from the lot liberated at the home site had been recovered, whereas 56 previously unmarked toads were taken in the same area during the period.

One other observation is worth recording: Although the toads listed in column E of table 3 had obviously not been seen around the plaza until they were captured and marked, after September 1 many of them were recovered several times subsequently. Unfortunately the same identifying mark was given to all toads collected during the period so that in many cases the precise identity of an individual was not certain. However, when a freshly marked toad was found in approximately the same place night after night it is a safe assumption that in most cases it was the same toad. In one instance it was definite. On the night of August 31 a toad was found sitting on the walk near one of the buildings in the area. Examination disclosed the fact that on the right foot the third toe was abnormally long and coalesced with the fourth toe. Thus the individual, even without clipping toes, was readily identified on later nights. Although it was always picked up, examined, and then tossed 10 to 20 feet away into a patch of scrub palmetto, the toad was found night after night stationed on the narrow walk, and never more than a yard away from the spot where

it was seen on the first night. From the night of August 31 until September 14 the toad was absent from its accustomed place on only two evenings.

CONCLUSIONS: Inasmuch as toads tend to remain within a limited area, and only 10 of the 61 individuals liberated at the home site were recovered within a two-week period, it may be assumed that only 16.6 per cent of all toads present in the area to which collecting was confined were seen in the course of 14 nights. Toads from the lots liberated to the east, north, and west were recovered in the plaza and the vicinity in approximately equal numbers, five, six, and four, respectively, or on the average five, or 8.6 per cent of each lot. Approximately twice as many were recovered from the lot comprising the same number of individuals liberated at the home site. Thus, if the samples permit a reliable estimate of the actual number of toads from each lot that were present, and the 61 toads liberated at the home site presumably remained there, then in the course of 14 days approximately half as many toads or approximately 30 from each lot, must have returned to the home site from each of three points of release 700 yards distant. These data suggest, therefore, that approximately half of the toads released at a distance of 700 yards managed to return to the home site.

DISCUSSION

The irregular periods of activity and the uncertainty with reference to the movements of toads during the periods when they are abroad make it impossible to arrive at valid estimates of the total number of toads in a given area, or to ascertain how many are using a breeding site. Dice (1941) has discussed the technique employed in the second experiment, outlining his objections to the method when applied to mammal populations, and several of his criticisms can be applied to estimates of toads. When equal numbers of toads taken throughout an area are liberated in various directions, and when the same number of toads is marked and liberated in

the same area, the estimate of the number of returns is probably more nearly valid than an estimate of the population.

The number of toads recovered from Lot D liberated at the home site in the second experiment can be compared with the total number of toads found that were previously unmarked. If 10 toads (or 16.6 per cent) of the 61 marked and liberated at the home site were recovered, then 56 unmarked toads taken during the same interval should represent approximately 16.6 per cent of the total active population. On this basis there must have been 336 unmarked toads in the collecting area. This figure doubtless represents only an

estimate of the total number of toads that were abroad or that passed through the territory covered during a two-week period. A total of 200 toads had been marked and liberated at various distances in May and June, and 244 toads had been marked during the second experiment in August and September. Hence there were 444 toads marked and liberated in the vicinity, of which only 68 were seen again in the plaza during the period of the experiments.

It was estimated from the sample liberated in the home territory that approximately half of the toads taken to the points of release in each of three directions had returned. On the other hand, most if not all of the toads liberated at distances of 100 and 300 yards in the earlier experiment supposedly managed to return, even though scarcely more than half of each lot was recovered. But for other distances and directions the ratio of actual returns to the number retaken cannot be estimated. In any event the total number (444) of toads marked, plus the total number (336) of unmarked toads estimated by means of the sampling technique, indicate only that approximately 780 individuals were active in the vicinity of the plaza during the period of time that collecting was carried on. Toads were not only coming and going, aside from the 444 removed for experimental purposes, but those remaining were in hiding part of the time. It seems reasonable to assume, however, that similar percentages of each of the four lots used in the second experiment were abroad at the same time; hence the percentages of recoveries should be reliable indices and the estimates should be valid.

It has been stated that frogs are familiar with the details of their local habitats and that if they stray from their home territory they are able to find their way back even after long periods of time by "making use of land marks to a large extent" (Noble, 1931, pp. 405-406). This view is substantiated in part by the work of Yerkes (1905) and of Franz (1918). The experiments of Yerkes proved that vision as well as kinaesthetic factors were important in the establishment of the labyrinth habit,

and that associations persisted for at least a month. Franz found that *Bufo calamita*, with better vision than *Rana temporaria*, had less difficulty finding its way back to an accustomed retreat than the latter species. These laboratory experiments, therefore, point to the possibility that vision, kinaesthetic sense, and memory may each play some role in homing. The information derived from a study of one species unfortunately cannot be applied to problems concerned with another; experiments have demonstrated that various species of Salientia differ greatly, not only in their speed of learning but in their ability to remember. Moreover, the same species of toad that "remembered" a disagreeable morsel and avoided it for only two days acquired useless motor habits that persisted for a number of days (Buytendijk, 1918).

If memory, kinaesthetic sense, or vision is involved in homing it is important to know something of the normal movements of toads. Unfortunately the extent of the wanderings in *Bufo t. terrestris* has not been ascertained. Nichols (1937) reports that a toad, probably *Bufo woodhousii fowleri*, had spontaneously traveled 1400 yards when "not removed" from the home site. Blair (1943) states that in Oklahoma the American toad (*americanus*, placed as a subspecies of *terrestris* by Netting and Goin, 1946) traveled as far as 900 yards within 10 days, although there was the possibility of passive movement by flood waters. Evidently there is much variation in the activities of individual toads, since Blair found others only 45 feet from the original breeding site 15 days after marking them. Blair's data as well as Nichols' are of interest in that they demonstrate the possibility of a toad's being familiar with an area well over a mile wide. Moreover, their data indicate that toads may be somewhat less sedentary than the bullfrog, *Rana catesbeiana*, studied by Raney (1940) who found great variation in the distance that individuals of both sexes as well as juveniles would move. Some bullfrogs moved less than 100 feet throughout the summer, whereas the maximum was only 100 yards. Contrary to inferences that might be drawn

from McAtee's (1921) report, Raney found little evidence of well-developed homing behavior. It would seem possible that the bullfrog's apparent lack of ability to return to a home site is correlated with its disinclination to wander great distances. Data supplied by Breder, Breder, and Redmond (1927) for another frog belie this conclusion. These authors studied the normal summer movements in *Rana clamitans* and found them to be variable but on the whole restricted, although they concluded that "a well developed homing instinct" was present in the species.

It is noteworthy that when toads are removed far from the home site they often make no attempt to return. In order to verify this, 15 toads were transported from the Archbold Biological Station in Florida to Englewood, New Jersey, and liberated in a truck garden. Despite adequate cover, seven were seen the night following their liberation, and on following nights a few others could always be discovered. At least one individual was still living in the truck garden over a month after its liberation. Hamilton (1934, p. 90) reports that nine toads (*B. terrestris americanus*) were carried 4 miles from their home swamp and a year later four of them "apparently year old toads" were taken within a few rods of the point of release. His statement that "apparently no homing instinct was developed at this precocious age" carries the implication that only adult toads are able to return to the home site. Auditory cues may be important in homing, and juveniles would not respond to breeding choruses. However, other vertebrates with restricted powers of locomotion, notably box turtles and some of the sedentary birds, tend to remain where they are liberated if they are carried many miles from home. Thus it is not impossible that when toads fail to recognize any landmarks they too remain where they are liberated. Such negative evidence scarcely proves that toads rely upon familiarity with their surroundings and find their way home by means of visual cues. The few data are suggestive, but they do not rule out the possible significance of auditory cues.

The evidence provided by the first ex-

periment described above points to the complexity of homing behavior. A higher percentage of toads returned that had been released a mile away in unfamiliar territory (as suggested by the absence of the species in the habitat) than returned from a distance of 850 yards over terrain that supposedly might have been known to the toads if their normal movements approximate those of the subspecies *B. t. americanus*. Factors other than familiarity with details in their home range probably are involved, and it can scarcely be postulated that the absence of heavy timber permitted toads a mile distant to identify landmarks at their home site. It would be preferable to assume that a higher percentage of toads liberated in the more agreeable surroundings tended to remain near the point of release because the territory was included in their normal range and hence was familiar. Or, in the negative it might be said that the familiar terrain was not so disturbing as the cleared area west of the Biological Station. An alternative explanation is discussed below.

It is not impossible that toads utilize topographical knowledge in returning to the home site. Cummings (1912) found that European newts (*Triturus*) showed a marked tendency to walk downhill. These newts were able to return to the home site from only short distances, and Cummings concluded that if they wandered from the precincts of their native pool they became lost and probably regained water only by chance. Boulenger (1912) commented on Cummings's paper and suggested that the European toad, *Bufo calamita*, would be a better animal for homing experiments because these toads congregate "from the neighborhood, often from a radius of half a mile. Thither all toads have travelled with remarkable directness, passing other ponds or ditches of which they might avail themselves were it not for the instinct which leads them to select a place offering all guarantees for the successful rearing of their progeny."

Boulenger's statement was accompanied by no data to confirm his conclusions, which may have been based largely upon field observations. Nevertheless his impres-

sion appears to be essentially correct, despite the teleological connotations of his interpretation. Toads evidently congregate at breeding sites, and it is manifest that they come to such sites from several directions, regardless of whether they are traveling uphill or downhill. The area where experiments were conducted in Florida is virtually flat, although a hill rises to the east, beyond the easternmost place of liberation for any lot of toads. Toads taken to the east or to the west, however, were released at points a few feet higher than the plaza (see map, fig. 2). Those taken to the north were a few feet lower than the plaza, but they returned in approximately the same percentages as those released to the east when proportionate distances are taken into account. In the second experiment the returns from the north slightly exceeded those from the east or west. There is little indication, therefore, that the topography, as such, plays any role of importance in toad homing.

The site immediately west of the Archbold Biological Station was the only place within a radius of at least 2 miles where breeding was noted, and presumably all the toads taken there represent one colony. The ditches and pools serve as a sort of center for the colony. Most, if not all, of the toads in the vicinity probably have gone through their metamorphosis at this breeding site. Between breeding periods they presumably scatter, with the major portion going eastward from this center, either into seclusion or to establish a feeding site. It was mentioned that in one instance a toad was found at almost the same spot for 13 nights out of 15, despite the fact that this toad had not been seen previously. Evidently it had adopted the site when first discovered; it could not have been stationed there during the previous two weeks since the area where it was found was searched twice each night. Circumstantial evidence suggests, therefore, that toads remain inactive for prolonged periods, but emerge under suitable weather conditions to breed, or at other times to select feeding stations that are used night after night. Breder, Breder, and Redmond (1927) note that individual green

frogs frequently disappear from an accustomed site for a few hours or even several days and cannot be found elsewhere. After they had dredged ponds and made every effort to find such frogs without success, they gained the impression that there was some sort of periodicity in the movements of frogs that caused individuals to "hide away in inaccessible [*sic*] places, possibly after an extra large meal to await the processes of digestion."

What evidence there is suggests that a toad's activities are much like those of the green frog in this respect. Whereas much individual variation is manifest, many toads undoubtedly are not active throughout the summer. Moreover, it may be inferred that individual toads differ considerably in the extent of their wanderings. The data published by Blair and by Nichols indicate that some toads are comparatively stationary while others are traveling long distances. It follows that one toad might be "familiar" with considerably more territory than another. If this is so, and if visual cues play any role in homing, it is conceivable that only those toads return that have not been transported beyond territory previously known to them. This hypothesis would account for the decreasing percentages of recoveries from lots liberated at increasingly greater distances from the home site, but in the same sort of terrain. However, the relatively high percentage of recoveries in the lot liberated in the area not frequented by *terrestris* a mile to the west is not explicable on this basis.

Random radial scattering from the point of release can scarcely account for the toad's ability to return to the home site. The discrepancy between the percentages of returns from the two areas in the first experiment, the cleared area and the semi-virgin area, points to some other factor or factors. In the second experiment toads apparently returned from three directions in approximately the same numbers, regardless of the terrain. If the estimate of 50 per cent for actual returns in each of the three lots is valid, radial scattering alone would not account for so many returns, even though it be conceded that the extent

of the territory possibly familiar to the toads used is unknown.

The contrast in the results of the two experiments suggests that a temporal factor is involved. In the first experiment, where three months elapsed before collecting was terminated, the percentage of toads recovered from a point a mile distant in the cleared area slightly exceeded that for the recoveries of the lot released 850 yards to the north. In the second experiment toads presumably returned in almost equal numbers during a two-week period from three directions, although the sample recovered from the lot released in the cleared area was actually smallest. This might be interpreted to mean that approximately half the toads in any lot or sample of the population orient themselves and return promptly, whereas the others straggle in over a long period of time. If so, the stimulus to return is stronger in the stragglers in the cleared area, or else they eventually pick up cues more readily than toads to the east or north. Further work would be required to prove either hypothesis.

Carr (1940) reports that *B. t. terrestris* breeds in Florida from March 25 to September 5, and there were toads of the species calling at the Biological Station as late as September 14 when the experiments were being conducted. The call of the male not only attracts females but serves also to direct other males to the breeding site. Goldsmith (1926) demonstrated that both sexes of the spadefoot toad, *Scaphiopus hammondi*, were stimulated by calls of the same species. He placed several individuals in an open container and gradually approached a breeding site. A mile distant the toads remained quiet, but when he was within 600 yards they became excited and active. In the experiments at the Archbold Station the presence of breeding choruses near the plaza may have enabled toads to orient themselves by means of auditory cues. There is no evidence that the hearing of toads is more acute than it is in man, although experiments and field observations suggest that toads distinguish one call from another, and are most strongly attracted by calls of their own

species. When the experiments were being conducted in Florida so many species were calling simultaneously that it was impossible for the human ear to distinguish one call from another. At a distance the noise emanating from the breeding site was usually a din, although some species started calling earlier and others continued to call later in the night when the majority had ceased. The shrill voice of *Bufo quercicus* often drowned the call of *B. t. terrestris*. Consequently, it was impossible to ascertain the distance at which the call of the Carolina toad was audible to man.

Inasmuch as calls emanating from the breeding site attract both males and females of the same species it should be pointed out that during heavy downpours throughout the summer *Bufo t. terrestris* was breeding immediately west of the Archbold Biological Station. From time to time individual toads were calling from the deep, steep-sided drainage ditch east of the plaza. When there was sufficient rain to produce a foot of water in the shallow, grassy-banked ditch (not labeled on map, fig. 2) between the plaza and the railroad tracks the majority of toads were calling at that site. Later in the season when extremely heavy rains had produced large pools just west of the railroad, the ditches were abandoned and all breeding was carried on in the natural pools. Whenever there was marked breeding activity, as there was following every storm, the toads captured in the plaza were nearly all heading westward, presumably attracted by the breeding sites. Although repeated searches were made, no toads were ever found coming to the breeding sites from the cleared area west of the pools.

It seems doubtful whether many of the vast numbers of toads coming from the east had traveled great distances. They were crossing the plaza in maximum numbers on rainy nights immediately after dusk, and since they are nocturnal they could not have been traveling for prolonged periods. Virtually no toads were encountered east of some small truck gardens at the southwest corner of the property. Indeed, the bulk of the toads

appeared to be emerging from places of concealment in the gardens.

The toads used in the experiments, therefore, were probably toads that lived in the vicinity of the plaza, although many of them were obviously captured while they were merely passing through the area to which collecting activities were confined. It has been suggested that "frogs and toads may be directed to ponds because of their special sensitivity toward marsh odors or gradients of humidity" (Noble, 1931), although no one has yet ascertained precisely how a toad knows where the breeding site is located. Hormonal stimuli, coupled with seasonal hypertrophy of the gonads, which are in turn controlled by the anterior pituitary, appear to be released by the advent of rains and presumably cause the toad to seek a breeding site, but cannot affect the choice of sites. Breeding choruses constantly gain and lose members; all individuals do not arrive at the same time. Piatt (1941) reports that toads (*Bufo t. americanus*) in New York do not travel from one breeding site to another, but ordinarily leave the breeding site and do not return after mating and oviposition. Blair (1943), on the other hand, found that males of the same species in Oklahoma continued calling in one pond until mates were found, or sometimes migrated relatively short distances to another pond, and Savage (1934) states that male *Rana t. temporaria* remained behind in the pond after the female had departed, and often mated several times in one season.

Whereas several ponds variable in size and location came into existence following the heaviest rains at the Archbold Biological Station, the east side of the larger pond (figs. 3, 4, and 6) was definitely the principal breeding site. Individual toads were occasionally heard elsewhere, and until this pond was filled toads were breeding in the drainage ditch between the Station and the railroad tracks, as noted above. Under such conditions, where a single pond is the focal point for breeding, it is doubtful whether there is an appreciable amount of migration from one pond to another. The first toad to reach a pond may do so fortuitously. After he starts

calling, his voice supposedly attracts other males to the same site. In many instances the same pond is selected year after year, but it does not follow that the toad upon emergence knows the direction to any particular pond. Man-made excavations filled with water at the first rain may be selected as breeding places. Such circumstantial evidence strongly suggests that toads scatter following oviposition and establish feeding sites or remain in seclusion during dry intervals. But when a heavy rain provides suitable conditions for emergence, random wandering brings one or more toads, probably those that happen to be closest, to a suitable pond and their calls attract others of both sexes. Most toads, unlike the majority of frogs, utilize temporary pools, and their generally louder calls may be of greater significance in breeding for this reason. Frogs, such as *Rana t. temporaria* whose breeding habits were described by Savage, that breed in permanent pools could continue to call for prolonged periods whereas a toad could not. This may explain the repeated matings reported by Savage.

The significance of the breeding chorus appears to have been neglected in experiments dealing with homing in toads, although it furnishes the simplest explanation for the data available from the first experiment herein reported. It will be recalled that a relatively high percentage of toads were recovered from the lot released a mile away in open, cleared land that presumably was unfamiliar territory. It is well known that sound carries farther across open areas than it does across wooded areas since trees and shrubs tend to absorb or deflect sounds. Even though it could not be proved that the voice of *terrestris* could be heard at a distance of a mile under suitable conditions, it was obvious that the chorus was more readily heard to the west of the Station than it was to the east. If it is assumed that toads liberated to the west were able to orient themselves, and moreover were attracted by the calls of their own species, the difference between the percentages of recoveries from the lots liberated to the east and north and the percentage of recoveries from lots

liberated a mile to the west is readily explained.

When released in familiar territory, a toad may rely upon visual cues to return to a favored site, as it certainly does in a maze. When liberated beyond its familiar territory but within hearing distance of a breeding chorus, it could readily utilize auditory cues and return to the breeding site. But when a toad is released in unfamiliar territory beyond the point where it can hear a breeding chorus, it does not (and probably cannot) return to a home site.

Birds, of course, are known to undertake long and successful migrations without having covered the route before, and without older birds to guide them. Aside from these migrations, ornithologists recognize two other phenomena: (1) the ability of birds to return to the home site over unfamiliar territory, even when transported hundreds of miles into regions never previously visited, and (2) the ability of birds to orient themselves and return when released in familiar territory.

The migratory movements of amphibians are limited and in most instances represent nothing more than mass movements to the breeding site; there are no reliable reports of migrations over distances exceeding a mile. The birds that are able to return to the home site over distances of hundreds of miles are, of necessity, birds with strong powers of flight. Thus they may be familiar with considerable territory even though there is seemingly little correlation between the extent of normal home ranges and the distances that various species manage to cover in order to return to the breeding site. Pigeon fanciers, as is well known, make use of training flights to familiarize their birds with increasingly greater areas. Moreover, they select the more gifted pigeons for breeding stock. By such means they have changed the habits of birds that were originally sedentary. Without training, many sedentary birds are quite unable to return to a home site and simply establish themselves at the point of release. The same birds when liberated within their familiar territory can easily return to the portion of the range previously selected.

The behavior of toads, by virtue of their relatively limited powers of locomotion, more closely approximates that of the sedentary birds. When liberated in familiar territory the toad, like the bird, may utilize visual cues. Nevertheless the data derived from the first experiment indicate that a toad can return even though it be removed a mile from familiar territory. At distances of 4 miles, in the case of *B. t. americanus*, of hundreds of miles in the case of the only *B. t. terrestris* removed more than a mile, there was apparently no incentive for toads to return or even to wander far from the site of liberation. These data are not conclusive, but the toads' failure to return when transported beyond hearing distance of the breeding choruses points to auditory cues as a factor of importance in homing.

Far more work has been done with birds than with the Amphibia in an effort to explain homing. Despite the vast amount of information amassed no indisputable explanation has been achieved. Griffin (1944) has recently reviewed the ornithological literature and summarized the more acceptable theories. He concluded in part that "many, if not all, of the homing experiments on record could be explained by assuming that when released in unfamiliar territory the birds scatter at random and explore until they find familiar landmarks," and that "the combined use of familiar landmarks, together with simple geographical, and ecological relationships such as those described . . . seems more reasonable as an explanation of homing than the postulation of a new sense organ."

Whereas it is clear that toads are incapable of traveling long distances to return to a home site, the homing behavior of toads has features in common with those observed in terrestrial birds. Vision may play a dominant role in the homing of birds, but in the nocturnal toads auditory cues offer the best explanation for the sort of homing that has been described for them. Other sensory phenomena, including vision, kinaesthetic sense, and possibly olfaction, may be factors of importance, but response to the mating call, without better evidence

to the contrary, offers the most reasonable hypothesis to account for the high per-

centage of returns from unfamiliar territory.

SUMMARY AND CONCLUSIONS

Two experiments with the Carolina toad (*Bufo t. terrestris*), marked by removing toes, were carried out at the Archbold Biological Station near Lake Placid in central Florida. The region, including two types of terrain, is described, the rainfall is tabulated for the four-month period during which the experiments were in progress, and there is an account of the methods used. In all, 444 toads were marked and liberated, of which 68 were subsequently recovered at the home site, defined as an area 400 yards long and 100 yards wide. The home site was adjacent to a large pond that served as the focal point for breeding activities.

In the first experiment 200 toads were liberated in six lots between the dates of May 26 and June 9. Three lots were released to the west, at distances of 100 and 300 yards, respectively, and one of them a mile distant in cleared territory not inhabited by *Bufo t. terrestris* and presumably unfamiliar to it. Three other lots were liberated at various distances from the home site in the uncleared, semi-virgin area at distances of 450 and 750 yards to the east and 850 yards to the north, respectively.

The percentages of recoveries from the three lots liberated in the semi-virgin area decreased with the distance from the home site that the toads had been liberated: 36.8 per cent at 450 yards, 20.6 per cent at 750 yards, and 16.6 per cent at 850 yards. Percentages of recoveries from lots liberated in the cleared area to the west were relatively higher in proportion to the distances than those released in the uncleared area, over 50 per cent being recovered from the lots removed 100 and 300 yards. Of greater significance was the recovery of 18.6 per cent of the lot liberated 1 mile to the west in unfamiliar territory. This percentage of recoveries is nearly as large as the percentage for the lot released only 750 yards to the east in territory that could have been familiar.

In the second experiment a series of 244 toads, taken within three days at the home site, was divided into four lots, each comprising 61 individuals. On September 1 two lots were released at points 700 yards to the east and north, respectively, in the semi-virgin area, and a third lot was removed 700 yards to the west in the cleared area. In order to estimate the number of toads that returned (in contrast to the number actually retaken), the fourth lot was liberated near the center of the area wherein they were taken. During the 14 days following their release a search of the home area was conducted every night. Toads from the three directions were recovered in equal numbers (approximately 8 per cent of each lot), whereas twice as many toads (roughly 16 per cent) were recovered in the lot liberated at the home site. These data indicate that during a two-week period about half of the toads released in the three directions managed to return to the home territory.

The validity of the sampling technique used is discussed, and the conclusion is drawn that it has greater validity for estimating the actual number of returns in homing experiments than it has for estimating the total number of individuals in a population.

The normal movements of toads are discussed and, whereas data for the population of *terrestris* used in the experiments were not secured, the published information for related subspecies and species indicates that individual toads may wander as far as 1400 yards. Thus the normal range of an individual, and hence the territory with which it is familiar, may encompass an area a mile wide.

There is no evidence that topographical knowledge, as such, plays any role in homing behavior; toads return in comparable numbers from similar distances whether the breeding site is uphill or downhill from the point of release.

Variation in the extent of familiar

territory in the home range cannot account for the difference in the results of the two experiments described. Although toads may utilize and remember landmarks for long periods, as they do in learning a maze, this ability does not explain their seasonal migrations to breeding sites and seems to be of little importance in homing behavior.

Random radial scattering from the point of release does not account for the high percentages of returns. Even though scattering may be followed by exploration and a search for suitable landmarks it would fail to explain the relatively high percentage of recoveries of toads from unfamiliar territory as opposed to lower percentages of recoveries from areas that might with greater reason be assumed to be familiar. It is improbable that more toads return from the unfamiliar territory merely because it is "more disturbing" to them than familiar territory.

Auditory cues offer the best explanation for the homing ability of toads released

beyond territory familiar to them. A relatively greater percentage of toads returned from the cleared area uninhabited by *Bufo t. terrestris* than returned from the uncleared territory inhabited by, and possibly familiar to, the toads used in experiments. The calls from a breeding chorus carry farther over cleared land than they do across areas with a moderately dense vegetation that tends to absorb or deflect sounds. Hence the toads that returned from a distance of 1 mile in the cleared area to the west probably did so in response to mating calls of other males in the breeding chorus. This interpretation is in accord with the fact that toads carried beyond hearing distance of a breeding chorus make no effort to return. Within a familiar area the Carolina toad may utilize visual cues to find its way to a preferred feeding site, but when released at a distance beyond its home territory other sensory cues must be utilized if the toad is to succeed in returning.

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NOTES ON THE ORIGIN AND FUNCTION OF THE ARTIODACTYL TARSUS

BY BOBB SCHAEFFER

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INTRODUCTION

Artiodactyls appear for the first time in Lower Eocene (Wasatchian) deposits. At this early stage in artiodactyl evolution, the tarsus has already developed its characteristic form, including the double-trochleated astragalus, and is certainly the most diagnostic part of the skeleton. Although other features of the skeleton also suggest reference to this order, the dentition is very difficult or impossible to distinguish from that of the hyposodontid condylarths (Simpson, 1937).

The evolution of the astragalus from the generalized ferungulate to the artiodactyl type, accompanying changes in the calcaneum, and to a lesser extent alterations in the other tarsal elements resulted in the introduction of a basic ordinal character. Simpson (1944) has pointed out that the earliest known members of all the orders of mammals already possess most of their characters of ordinal rank. The hiatus between such primitive representatives of an order and their possible ancestors is usually great, with intermediate or transitional stages either unknown, or in some cases possibly not recognized. Hence the determination of a generalized ancestral condition and, more particularly, of the

transitional stages leading to such a basic ordinal character is necessarily largely inferential, based for the most part on a few characters that appear to indicate affinity and thus tend to bridge, however incompletely, the morphological gap. Thus in the Artiodactyla, the dentition seems to be the best connecting link between this order and a group of primitive condylarths, the tarsus and other parts of the skeleton offering no definite evidence regarding ancestry.

While the ancestry of a number of the modern orders of mammals must be traced back into the Cretaceous, and the time interval involved in their origin can only be very roughly estimated, many groups, such as the Rodentia, Chiroptera, Cetacea, and the various ungulate orders, very probably had a Paleocene origin. As the Paleocene had a duration of about 15 million years, the basic ordinal characters of these latter groups presumably developed in less than that time. The apparent relatively rapid evolution of such basic ordinal characters has been discussed by Simpson (1944) and by Wright in several papers and will not be elaborated upon here.

One of the most important factors in

the section pressure affecting a pre-artiodactyl population, particularly in unforested country, would be predator pressure. As Huxley (1942) has pointed out, the development of many ungulate specializations, such as the ability to ruminate and the various modifications permitting greater speed, were undoubtedly associated with the constant presence of predatory carnivores. Under such narrowly specified environmental conditions, wide variability would not be favored, and a highly specialized mechanism such as the artiodactyl tarsus could conceivably develop in a relatively short period of time. Once a definite trend towards an advantageous morphological specialization has been initiated in a population, it is highly probable that further random mutations favoring this trend would be preserved. Other mutations, although equally favorable but leading in a somewhat different adaptational direction, would be less likely to survive.

A trend of this sort could have continued to develop under the impetus of selection pressure until the biomechanical limit of specialization was reached (Huxley, 1942), the point at which theoretically the greatest possible degree of mechanical efficiency is attained. As stated before, the basic pattern of the artiodactyl tarsus was already fully developed in the Lower Eocene, and it would appear that the biomechanical limit was practically reached at that

time. This was almost certainly true of the astragalocalcaneal complex, as the morphology of these elements has been altered but little excepting for minor refinements. The more distal portion of the tarsus, in certain families, has experienced some fusion and elimination of elements resulting in greater tarsal consolidation.

Matthew was well aware of the conservatism of the astragalus within a given order of mammals and laid great stress on its importance in taxonomy, although, to the writer's knowledge, he never speculated as to the reason for its resistance to further adaptational change.

The purpose of this paper is to consider, on the basis of known evidence, the transformation of the primitive ferungulate tarsus into the artiodactyl type, with particular reference to the astragalocalcaneal complex. The accompanying functional changes are discussed together with a consideration of the mechanics of the definitive artiodactyl tarsus.

The writer is obligated to Dr. M. A. Emmerson of the School of Veterinary Medicine of the University of Pennsylvania for the roentgenograms of the hind limb of a dog, goat, and pony in different stages of dorsiflexion and to Drs. W. K. Gregory, G. G. Simpson, and E. H. Colbert for helpful advice. The illustrations were prepared by the Illustrators Corps of the American Museum.

THE PRIMITIVE FERUNGULATE TARSUS

The resemblance between the dentition of the hyposodontid condylarths and the bunodont artiodactyls is considered by Simpson to be too great to be ascribed to convergence, and it is therefore possible that the primitive hyposodontids represent the ancestral stock from which the artiodactyls arose. Pearson's (1927) observation of the close similarity between the mastoid region of the meniscotheriid condylarth *Pleuraspidothierium* and that of the primitive artiodactyls further supports this general hypothesis. Simpson's (1945) coining of the term Ferungulata as a cohort, including both the carnivores and ungulates,

is a major step in the development of a natural classification of a greatly differentiated group with a common Paleocene origin.

From the standpoint of the tarsus alone, the hyposodontids are certainly not so close to the primitive artiodactyls as to the arctocyoniid creodonts (fig. 1A, B). This is well demonstrated by a comparison of the astragalus of the Lower Paleocene hyposodontid *Choeroclaenus* and that of the arctocyoniids *Loxolophus* and *Claenodon*. In these genera, this element is of a primitive, generalized nature with a very shallow tibial trochlea and transversely

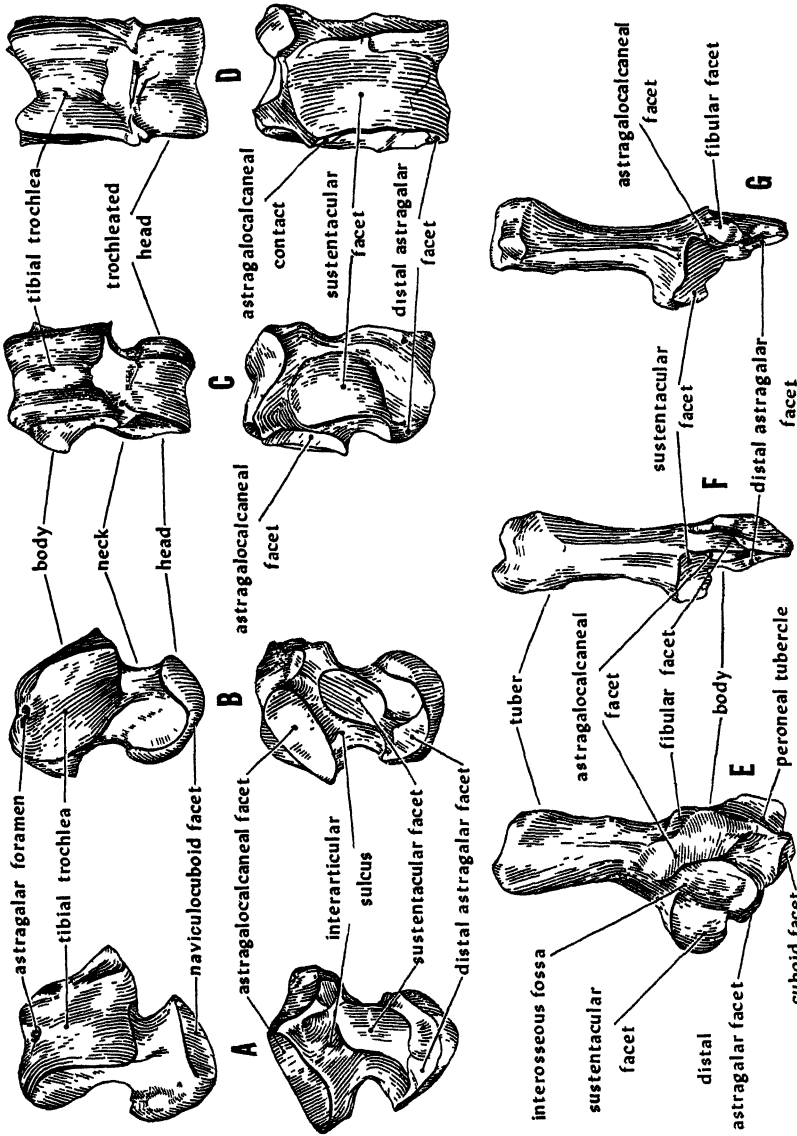


Fig. 1. Dorsal and ventral views of the astragalus and distal views of the calcaneum showing the morphological features discussed in the text. A, *E. Cluadon*. B, *Chorochlanus*. C, *Diacodexis*. D, G, *Ovis*. F, *Merycochoerus*.

flattened head. In view of this basic resemblance, and the evidence offered by the dentition mentioned above, the artiodactyl tarsus could be derived validly from either the artocyonid or the hyposodontid type.

Matthew (1937) concluded that the non-serial or alternating tarsus, with an articulation between the astragalus and cuboid was the primitive eutherian condition, thus disagreeing with Cope's thesis (1881) that the serial tarsus of such types as *Phenacodus* represents the generalized ancestral pattern. The non-serial arrangement is characteristic of the artiodactyl tarsus and is almost without question a heritage character from the artocyonid-hyposodontid non-serial tarsus. In its functional significance, the tarsal pattern is undoubtedly correlated with weight distribution in the foot. In ungulates the non-serial tarsus is associated with the paraxonic foot, while there is a tendency, never quite consummated, for the mesaxonic type to be associated with the serial tarsus. Actually, in cursorial perissodactyls, the astragalocuboid contact is so small that the tarsus is functionally serial in type. This divergence in tarsal pattern must have occurred in the primitive ferungulate stock, and the resulting difference in weight distribution undoubtedly accompanied the development of the paraxonic foot in the artiodactyls and an approach to the mesaxonic type in the cursorial perissodactyls.

The primitive ferungulate astragalus is divided by a constricted neck into a proximal body and a distal head. The tibial trochlea, on the dorsal surface of the body, is very shallow, and the trochlear crests consequently are low and poorly defined. The body is oriented at an angle of about 30 degrees with a longitudinal axis passing through the neck and head.

A large astragalar foramen, extending plantarward to the interarticular sulcus, is located on the posterior surface of the trochlea. It has been stated that this foramen, or whatever passed through it, was responsible for greatly restricted movement in the upper ankle joint. The trochlear articular surface, however, extends

posteriorly on both sides of the foramen, as in *Orycteropus*, which, incidentally, has a primitive ungulate-like posteranial skeleton (Colbert, 1941). The tibia covers the foramen during complete plantar flexion in the aardvark and must have done so in the primitive ferungulates. Thus the range of movement in the upper ankle joint of, for instance, *Claenodon*, formed an arc of about 75 degrees. The ontogeny of the astragalar foramen has not been worked out. In an adult *Orycteropus* dissected by the late Mr. H. C. Raven, only some connective tissue was found passing through the canal, and there is no evidence histologically of degenerated blood vessels or nervous tissue or of any clear-cut relationship with the interosseous ligament.

In dorsal aspect, the astragalar neck has no important morphological features. The head is dorsoventrally compressed and is divided into two distinct articular surfaces. The naviculocuboid facet, which is not clearly subdivided, is slightly curved both dorsoventrally and mediolaterally. The other facet, running along the median side of the neck and confluent with the naviculocuboid, is the articular surface, according to Matthew (1937), for a small ossicle which he considered to be a persistent reptilian tibiale. Although the homology of this bone might be questioned, its presence in *Claenodon* is beyond doubt, and the necessary facet is found in other artocyonids and in *Choeroclaenus*.

On the plantar surface of the astragalus, the astragalocalcaneal facet (ectal facet of Osborn, 1890) is a narrow, concave oval area located along the lateral border of the body. The long axis of this facet is oriented at an angle of about 40 degrees with the long axis of the entire bone, and its oblique position causes it to be produced laterally at its distal end well beyond the body.

The sustentacular facet of the astragalus is mostly located on the plantar surface of the neck and is separated from the astragalocalcaneal facet by the deep interarticular sulcus. It is ovoid in shape and gently concave, with its long axis making an angle of about 15 degrees with the long axis of the entire bone.

The triangular distal astragalar facet is located on a ridge running mediolaterally from the sustentacular facet and is confluent with the articular surface of the head. It is the only contact between the astragalar head and the body of the calcaneum. On the latter the distal astragalar facet is represented by a narrow transverse shelf along the dorsal border of the cuboid facet.

The calcaneum (fig. 1E) has a massive appearance when compared to the typical fissiped or ungulate type. The astragalocalcaneal facet, located at the proximal end of the calcaneal tuber, is oriented at an angle of about 30 degrees with the long axis of this bone and is tilted at about a 45-degree angle. It is roughly ovoid and is continuous with the convex fibular facet that is situated along its upper rim, facing dorsally.

The sustentaculum is separated from the astragalocalcaneal facet by the interosseus fossa, which, together with the interarticular sulcus of the astragalus, forms the sinus tarsi for the interosseous ligament. The sustentacular facet, located on the dorsal surface of the sustentaculum, is

essentially round and slightly concave. It is tilted anteriorly in such a manner that the articular surface is oriented at a 30-degree angle with the longitudinal calcaneal axis.

The peroneal tubercle, located on the lateral surface just proximal to the cuboid facet, is very prominent and is grooved on its dorsal surface for the passage of the peroneus longus tendon. The cuboid facet covers almost the entire distal end of the calcaneum. It is roughly rhomboidal and slightly concave.

The more distal tarsal elements will not be discussed in detail except for the mention of several important features. The navicular and cuboid have an S-shaped articulation in proximal view, preventing any movement between them. The basin-shaped articular surface for the astragalus is rimmed by the outer edge of the navicular and the medial edge of the cuboid. The calcaneal facet of the cuboid is slightly convex, and the edges of the facet are not elevated. There is a well-defined groove on the lateral surface of the cuboid for the tendon of the peroneus longus.

THE JOINTS OF THE PRIMITIVE FERUNGULATE TARSUS

In order to follow in greater detail the changes in the orientation of the tarsal joints from the primitive ferungulate to the artiodactyl type, the axes of the upper ankle joint (crurotarsal joint), the lower ankle joint (astragalocalcaneal joint), and the transverse tarsal joint will be considered separately. These axes have been located by obtaining the center of curvature of each pertinent articular surface and marking the center, where possible, on the surface of the astragalus or calcaneum. The accuracy of these determinations was tested by articulating the crural and proximal tarsal elements by wires running through these centers in such a fashion that approximately normal joint movement could be observed. While this was done with the ligaments in place in a recent artiodactyl, it was necessary to use accurately made plaster casts for the fossil form (*Claenodon*).

The upper ankle joint is located (figs. 2a, 3a) between the tibia and fibula on one side and the astragalus and calcaneum on the other. Movement at this joint in all terrestrial mammals is largely restricted to dorsiflexion and plantar flexion (extension) of the foot on the crus. Such limitation of motion probably was present in the most advanced therapsids, following the development of a trochleated astragalus and external and internal malleoli.

Although the trochlear crests are very low in the primitive ferungulates, the external and internal malleoli are well developed and probably prevented any possibility of horizontal rotation at this joint. The axis of the upper ankle joint in *Claenodon* (fig. 2A) passes from the middle of the dorsal border of the astragalocalcaneal facet to a point on the rim of the sustentacular facet of the calcaneum. This axis is thus oriented at right angles to the

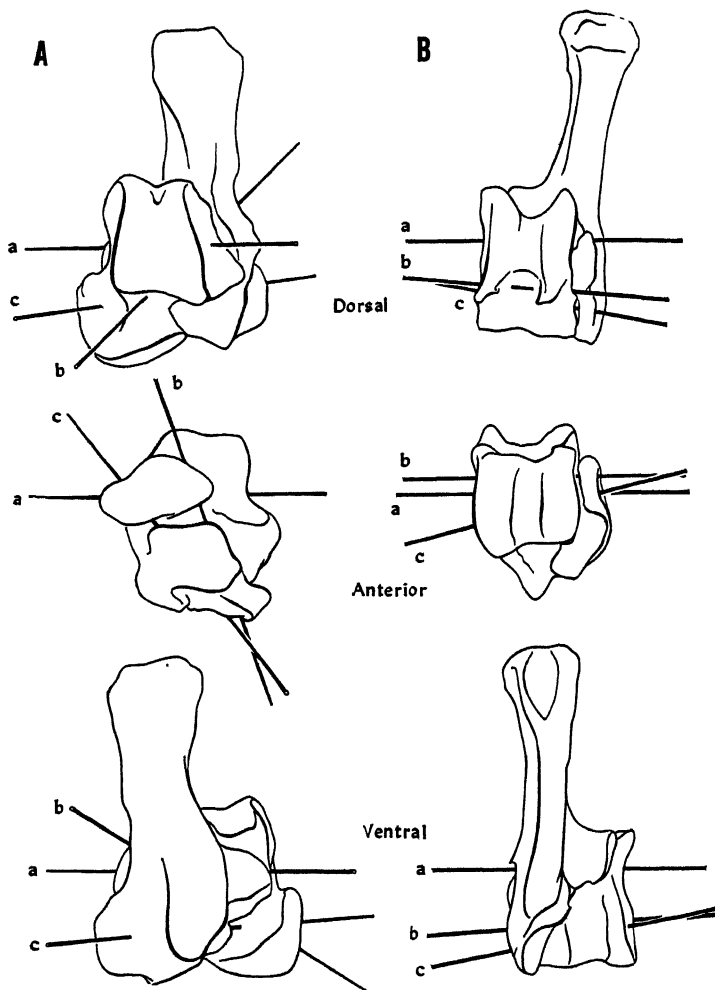


Fig. 2. The articulated astragalus and calcaneum of (A) *Claenodon* and (B) *Ovis* in dorsal, anterior, and ventral views, oriented with the axis of the upper ankle joint in the horizontal plane. Abbreviations: a, axis of upper ankle joint; b, axis of lower ankle joint; c, axis of transverse tarsal joint.

tibial trochlear crests as in man (Elftman and Manter, 1935) and as might be expected in a simple ginglymoid joint.

The lower ankle joint (fig. 1A, B, E) between the astragalus and calcaneum, is composed of three articulations, the astragalocalcaneal, the sustentacular, and the distal astragalar. The axis for this joint, as pointed out by Fick (1911), must be considered as a compromise axis for the articulations involved. It has a very oblique position in *Claenodon* (fig. 2A),

running from a point on the middle of the dorsal surface of the neck distal to the tibial trochlea, to a point on the lateral side of the calcaneal tuber on the same level as the peroneal tubercle.

Movement at the lower ankle joint has been described by Fick and others as essentially a rotation about a compromise axis of the entire portion of the foot below the astragalus and resulting in eversion and inversion of the foot. In this connection the rounded astragalar head is of great

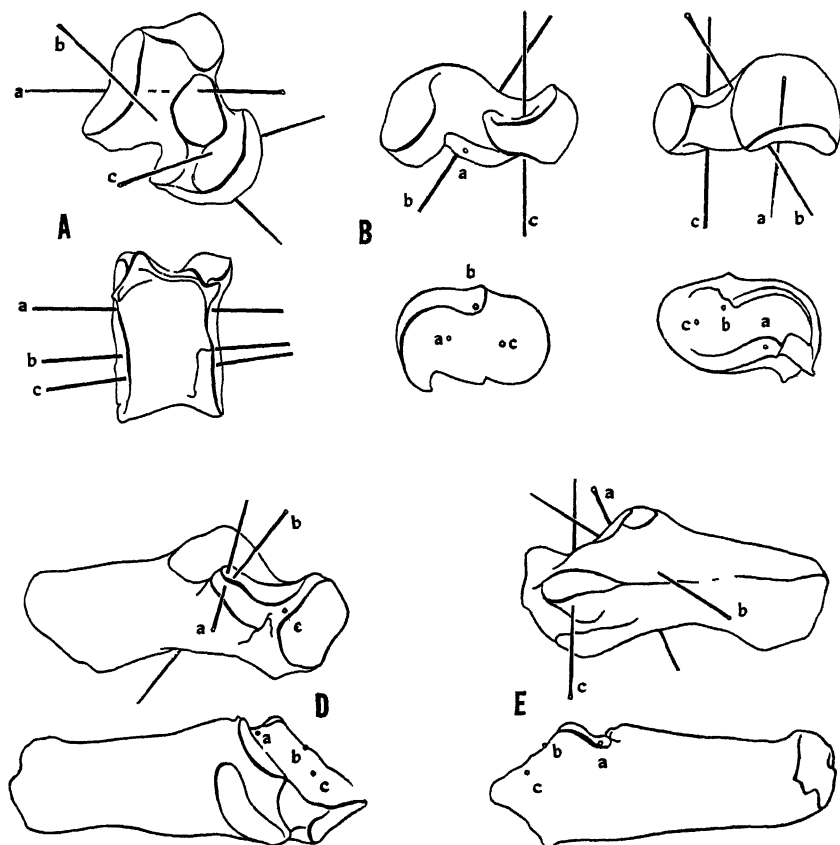


Fig. 3. A comparison of the relative positions of the axes of the three tarsal joints in *Claenodon* (upper illustration of each figure) and *Ovis* (lower illustration of each figure). A. Ventral view of astragalus. B. Medial view. C. Lateral view. D. Medial view of calcaneum. E. Lateral view. The axes indicated by circles are oriented at right angles to the plane of the figure. The positions of the axes in the calcaneum of *Ovis* represent the situation at extreme plantar flexion. Actually, the axis of the lower ankle joint is the only one bearing a constant relationship with the calcaneum during astragalar rotation. Abbreviations: a, upper ankle joint; b, lower ankle joint; c, transverse tarsal joint.

importance during eversion and inversion as it gives the navicular the necessary freedom of movement. The functional model of the *Claenodon* foot clearly demonstrates that such movement occurred about the compromise axis. It was important in maintaining balance through postural adjustment during locomotion.

The transverse tarsal joint is located between the astragalus and the calcaneum on the one side and the cuboid and navicular on the other. The axis of this joint is difficult to determine with accuracy in

the *Claenodon* foot. Fick (1911) and Elftman and Manter (1935) differ in their opinions as to its location in man. The difficulty lies in the analysis of the movement that occurs at this joint. The studies of Weidenreich (1921) and Elftman and Manter demonstrate that in mammals with a well-defined motion at the transverse tarsal joint, the movement should be considered simply as dorsiflexion and plantar flexion rather than eversion and inversion. In man, these authors have shown that the transverse tarsal joint is normally fixed in

a dorsiflexed position, producing the longitudinal arch. In the chimpanzee and in other primates it is movable, permitting dorsiflexion and plantar flexion.

In *Claenodon*, as in most non-cursorial mammals, the astragalonavicular articulation is a saddle joint, while the calcaneocuboid articulation is ellipsoidal. As two joint articulations are again involved, a compromise axis must be determined. Sobotta and McMurich (1914) point out that, although these articulations are primarily biaxial, they check each other in a reciprocal fashion so that during actual motion of the entire transverse tarsal joint a common uniaxial hinge joint results. The axis in *Claenodon* (fig. 2A) passes from about the midpoint on the medial face of the astragalar head to the lateral surface of the calcaneum immediately under the peroneal tubercle.

The extent of movement in the transverse tarsal joint of *Claenodon* cannot be accurately determined. The close similarity between the form of the articular surfaces in *Claenodon* and in the chimpanzee, where motion is known definitely to occur, indicates that at least a limited amount of movement was possible. Furthermore, X-rays of the canid tarsus (fig. 4A) demonstrate that very limited motion occurs at this joint during dorsiflexion and plantar flexion, foreshadowing the condition in the artiodactyls. The significance of such movement is problematical in a non-arboreal, non-grasping foot, and it might be simply a passive effect of foot action. There is no reason for believing that the transverse tarsal joint in *Claenodon* was fixed as it is in man, even though the foot was semiplantigrade (Matthew, 1937). A range of movement about equal to that in the dog probably existed.

THE PRIMITIVE ARTIODACTYL TARSUS

The dichobunid artiodactyl *Diacodexis*, from the lower Eocene Wasatchian (Gray Bull) deposits of North America, is the earliest known member of the Artiodactyla. It was small, lightly built, and presumably had five toes, although this is not certain. In any case, the tarsus completed its transformation into the artiodactyl type before there was any significant alteration in the digits by way of reduction in number or increase in relative length. This fact is of importance in considering the mechanical advantage of the tarsus in the more primitive members of the order.

The astragalus of *Diacodexis* (fig. 1C) is typically artiodactyl in all respects. The tibial trochlea is deeply grooved, and the trochlear crests are sharp. The trochlea is oriented at an angle of about 12 degrees (trochlear angle) with the long axis of the entire bone, representing a definite reduction in the size of this angle from the condition in *Claenodon*. The relationship between the position of the tibial trochlea and foot motion is obvious. The larger the trochlear angle, the greater the amount of pedal eversion in dorsiflexion, an important factor during the rapid locomotion of a

long-limbed ungulate or carnivore. The tibial trochlea has often been compared to a screw mechanism, with the pitch of the screw directed outward.

The astragalar neck is recognizable only in dorsal aspect as a somewhat constricted area between the tibial trochlea and the head. The elaboration of the latter into a second trochlea resulted in an encroachment on the primitive neck area.

The astragalar head is dorsoventrally compressed to some extent, as in the primitive ferungulates. It is no longer rounded mediolaterally, however, but has sharp angular medial and lateral borders. The trochlear surface is divided into distinct cuboid and navicular facets, separated by a rather pointed crest. The navicular portion of the trochleated head curves onto the plantar surface, while the cuboidal part ends abruptly before reaching the sustentacular facet. The position of the head, with its longitudinal axis almost in line with that of the body, is undoubtedly associated with the fact that the astragalus transmits most, if not all, of the body weight directly from the tibia to the cuboid and navicular.

The distal astragalar facet is a semi-circular articular surface on the lateral side of the head and is confluent with the cuboidal portion of the head. It is relatively larger than in *Claenodon* and is of greater functional importance.

The plantar surface of the artiodactyl astragalus is dominated by the sustentacular facet. It is a long narrow oval with the long axis coinciding with the long axis of the entire bone. The astragalocalcaneal facet has an outline similar to that found in *Claenodon*; its long axis, however, parallels that of the sustentacular facet. The interarticular sulcus has virtually disappeared with the loss of the interosseous ligament and the approximation of the astragalocalcaneal and sustentacular facets. The former position of the sulcus, however, can still be readily determined in most primitive artiodactyls as a very shallow groove.

The oreodont calcaneum (fig. 1F), which

is very similar to the available fragmentary *Diacodexis* calcaneum, is mediolaterally compressed, particularly in the body. As in the astragalus, the long axis of the astragalocalcaneal facet is about parallel to the long axis of the entire bone and is in a more vertical position than the homologous facet in *Claenodon*. The fibular facet has essentially the same orientation. The sustentaculum is buttressed against the proximal portion of the tuber and does not project medially as a well-defined shelf as in *Claenodon*. The sustentacular facet faces distally and hence cannot function as a support for the astragalus, as pointed out by Forster (1926), but only as a guiding surface during astragalar rotation.

As a result of the compression of the body of the calcaneum, the slightly concave cuboid facet is very narrow mediolaterally. It is confluent with the distal astragalar facet that is located on the medial surface of the body.

THE JOINTS OF THE ARTIODACTYL TARSUS

The axes of the upper and lower ankle joints and the transverse tarsal joint have been determined for *Ovis* in the same manner as for *Claenodon*. The small size of the tarsus and the lack of sufficient material make it impossible to determine accurately the axes in any of the dichobunids. A detailed comparison of the tarsal elements, however, indicates that the orientation of these axes is essentially the same for all artiodactyls, including the most primitive types. Because the astragalus moves independently of the calcaneum, it is not possible to locate all the axes in relation to the calcaneum, as was done for *Claenodon*.

The axis of the upper ankle joint (figs. 2B, 3) is similar in orientation to that of *Claenodon*. It passes from the outer edge of the sustentacular facet of the astragalus to a point on the medial surface of the astragalus. The slight obliquity of this axis is due to the fact that the lateral trochlear crest of the astragalus has a greater curvature than the median. This axis in dorsal aspect is oriented at right angles to the crests of the tibial trochlea. The increase in the depth of the trochlear groove and the de-

velopment of a flange or intermediate malleolus (Grant, 1940) on the anterodistal surface of the tibia which fits into this groove, along with the medial and lateral malleoli, insure limitation of movement to one plane. The articulation of the lateral malleolus (fibula) with the calcaneum further serves this purpose.

Movement of the lower ankle joint (figs. 4B, 5) in the Artiodactyla is simply a restricted rotation of the astragalus in a fore-and-aft direction. Such movement is possible because of the parallel motion at the astragalocalcaneal, sustentacular, and distal astragalar facets. For practical purposes, therefore, the functional axis of the lower ankle joint may be considered to be the axis of the sustentacular articulation, and this can be convincingly demonstrated in the working model. In other words, this axis is not a compromise axis, as it probably is in most or all other orders of mammals, but the actual pivot for all three articulations.

The axis of the lower ankle joint (figs. 2B, 3) passes through the astragalus very near its anterior surface and immediately



Fig. 4. Roentgenograms of the tarsus of a living dog (A), goat (B), and pony (C), showing the foot in different stages of dorsiflexion. The photographs have been oriented with the metatarsals in a vertical position.

above the border of the distal trochlea (astragalar head). This axis thus parallels that of the upper ankle joint in a modified horizontal plane and converges slightly towards it medially in a semifrontal plane. The astragalocalcaneal facet apparently lost much of its functional im-

portance in the artiodactyls with the enlargement of the sustentacular facet and the change in the orientation of the lower ankle joint axis. While it is still present in palaeodonts, suids, ancodonts, and oreodonts, it has all but disappeared in the tylopods, tragulids, and pecorans. The

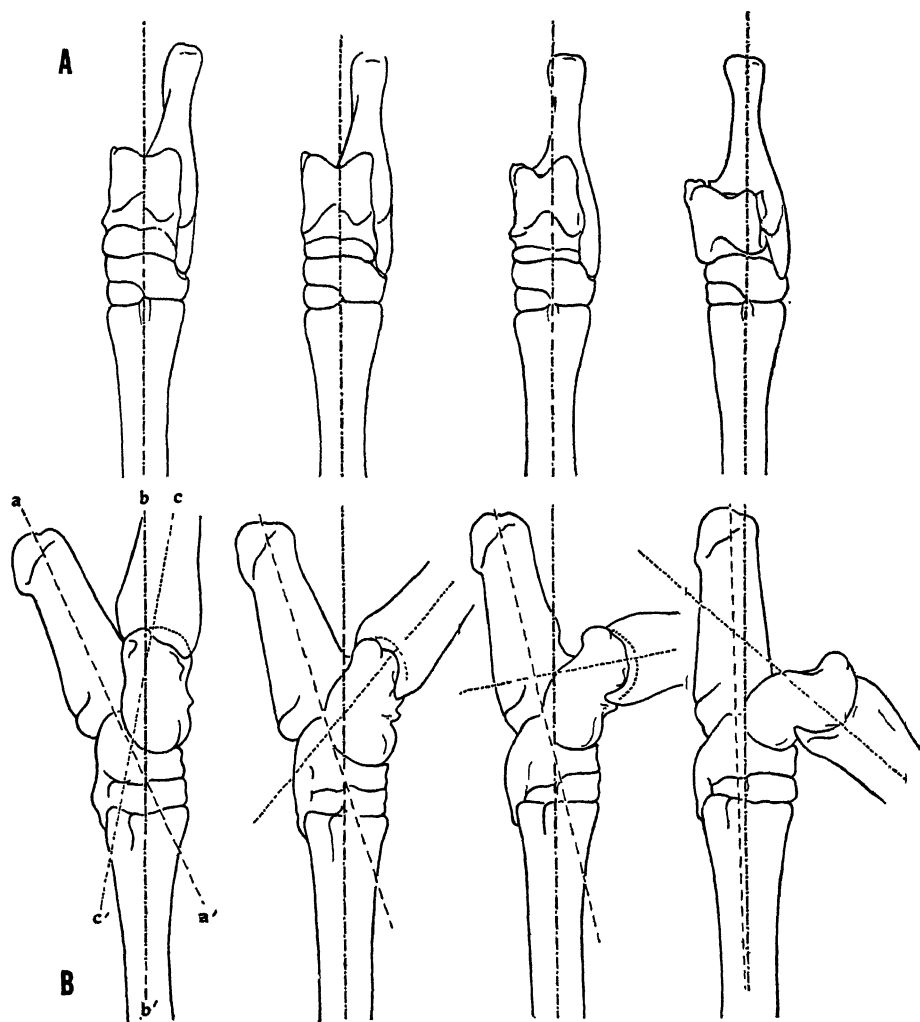


Fig. 5. Series of outlines showing the relationship between the astragalus and calcaneum during astragalar rotation. Series A (anterior view) demonstrates the movement of the calcaneum towards the midline, which is represented by the longitudinal axis of the fused metatarsals. Series B shows the movement of the calcaneal tuber into a position almost paralleling the longitudinal axis of the metatarsals. Abbreviations: a-a', longitudinal axis of calcaneal tuber; b-b', same for metatarsals; c-c', same for tibia.

great reduction in the size and distinctness of this facet in the last three groups is the only major refinement occurring in the artiodactyl astragalus since its first known appearance in the Lower Eocene.

The action of the transverse tarsal joint (figs. 4B, 5) is limited, as in *Claenodon*, to dorsiflexion and plantar flexion of the more

distal portion of the foot. Because of the presence of the trochleated astragalar head, the axis can be more readily and accurately determined than in *Claenodon* (figs. 2B, 3). It passes through the astragalus in the mid-frontal plane below the anterior dorsal border of the trochleated head. The arc of the portion articulating

with the navicular represents more than a half circle and is somewhat larger than that of the cuboidal portion, accounting for the fact that this axis converges towards the other two axes on the medial side and is diagonally placed in relation to them. The calcaneocuboid articulation has an entirely different motion that may be considered as subsidiary to the movement of the astragalus just described. During astragalar rotation, the calcaneum slides proximally or distally along the obliquely placed calcaneocuboid facets (fig. 5), the course of movement depending on the direction of astragalar rotation. It would appear, therefore, that the calcaneocuboid articu-

lation cannot be considered as a functional part of the transverse tarsal joint but rather that movement at this articulation is a result of action at the lower ankle and transverse tarsal joints.

The orientation of the three tarsal axes clearly reflects the essential similarity of the movement occurring at the upper, lower, and transverse tarsal joints. The most radical departure from the usual mammalian condition occurs in the lower ankle joint. Eversion and inversion are no longer possible, and this movement has been translated into the comparatively simple fore-and-aft rotation of the astragalus against the calcaneum.

THE TARSAL LIGAMENTS

Ligaments are differentiated portions of the joint capsule and serve both to give stability to the joint and to restrict movement to certain more or less definite planes. As ligaments probably develop in relation to lines of tension resulting from joint function, they are presumably poorly differentiated until such function begins after birth (Clark, 1939). Elftman and Manter (1935) have pointed out that the problem of whether ligaments or muscles limit joint movement has not been settled experimentally (for instance in the maintenance of the longitudinal arch in the human foot). In ginglymoid diarthrodial joints, the ligaments are obviously of importance in preventing over-rotation and dislocation.

Camp and Smith (1942) have experimentally demonstrated the importance of the digital spring ligaments during locomotion in the horse where, through their elasticity, they play an active role in propelling the body. Most ligaments, however, such as those around the tarsus, are but slightly extensible, although the lateral and medial tarsal ligaments must be taut at all times to provide the necessary joint stability. The ligaments and the joint capsule on the anterior and posterior surfaces of the tarsus, however, are lax enough to permit the proper degree of dorsi-flexion and plantar flexion.

While it has not been possible to conduct

experiments on the function of the tarsal ligaments in living carnivores and ungulates, the hind limbs of a dog, horse, and deer were fixed in Klotz's fluid so as to permit manipulation of the joints and to observe the effect of the ligaments. The basic resemblance in the subdivision and arrangement of the tarsal ligaments in fissiped carnivores and artiodactyls is quite evident (fig. 6), although in the latter certain ligaments have been eliminated.

On the lateral aspect of the tarsus there are two ligaments arranged in crisscross fashion, with their fibers almost at right angles to each other. The superficial calcaneofibular ligament extends from the lateral malleolus forward to the lateral surface of the body of the calcaneum, the cuboid, and proximal portion of the lateral metatarsal. The deep calcaneofibular ligament extends in the opposite direction, from the anterior surface of the external malleolus to the proximal portion of the calcaneal tuber.

In the dog, with motion in the tarsus mostly restricted to the upper ankle joint, these ligaments are thin bands. In the artiodactyls, on the other hand, they are relatively much larger, with a tendency towards spiraling of the fibers. Here these ligaments are concerned with maintaining the integrity of the lateral side of the ankle during movement at the upper and lower

ankle joints and the transverse tarsal joint. They do not appear to be concerned with limitation of movement but rather with maintaining the proper articular relationships. The spiraling of the fibers enables the ligaments to exert a constant restraining influence by bringing the properly directed fibers into play at the proper time. The crisscross effect tends to prevent any

The third ligament on the lateral side is the astragalofibular ligament, extending from the posterior border of the external malleolus to the proximolateral corner of the lateral trochlear crest. Its attachment on the external malleolus being close to the axis of the upper ankle joint, this ligament remains taut throughout flexion and extension at that joint. It supple-

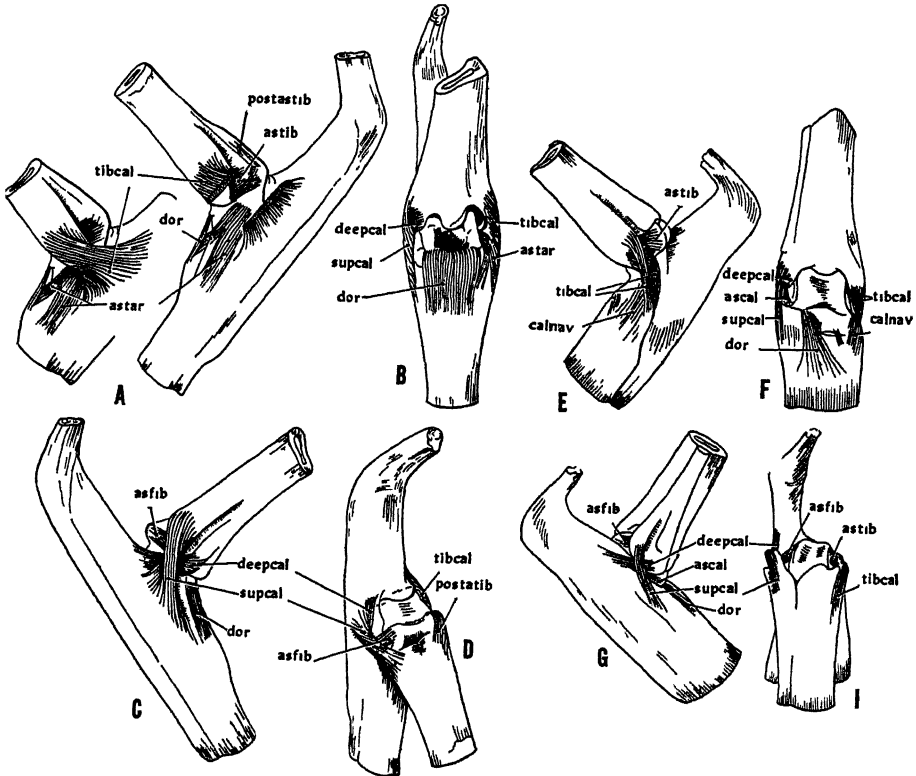


Fig. 6. The tarsal ligaments of a deer (A-D) and a dog (E-H). A, E. Medial. B, F. Anterior. C, G. Lateral. D, H. Posterior. Abbreviations for ligaments: ascal, astragalocalcaneal; asfib, astragalofibular; astar, astragalotarsal; astib, astragalotibial; calnav, calcaneonavicular; deepcal, deep calcaneofibular; dor, dorsal; postastib, posterior astragalotibial; supcal, superficial calcaneofibular; tibcal, calcaneotibial.

shearing action, particularly at the upper ankle joint. The subdivision and crossing of the two parts of the calcaneofibular ligament are apparently associated with the digitigrade or unguligrade posture of the foot, positions in which the tendency towards shearing would be greater than in the plantigrade or semiplantigrade posture.

ments the function of the deep calcaneofibular ligament and also, in the artiodactyls, assists in producing astragalar rotation during dorsiflexion.

On the medial surface of the tarsus the calcaneotibial ligament (part of the deltoid ligament of man) passes from the medial malleolus to the medial surface of the sustentaculum, navicular, and third cunei-

form. In the dog it is subdivided into two narrow bands, while in the pig and goat it is a single thick ligament with spirally arranged fibers. The spiraling effect serves much the same purpose as the crossed and spiraled ligaments on the lateral side of the tarsus, in that differently directed fibers become effective at different times during dorsiflexion and plantar flexion.

The calcaneofibular and calcaneotibial ligaments in the dog are concerned with maintaining the integrity of the upper ankle joint only. In the artiodactyls, they are also entrusted with the union of the lower ankle joint and the transverse tarsal joint, which accounts for their relative increase in size and complexity. These ligaments appear to have no direct relationship with the axes of the joints but rather are located in positions of greatest stress, the latter being produced by movement about the axes. They are elastic enough to maintain the proper contact at the upper and lower ankle joints during outward astragal rotation when the space occupied by the astragalus decreases. As outward rotation progresses, they pull the calcaneum anteriorly and medially.

The astragalotibial ligament extends from the posterior surface of the medial malleolus to the medial surface of the body of the astragalus. It serves much the same function as the astragalofibular ligament.

In the artiodactyls and perissodactyls there is a strong ligament running from the medial surface of the astragalus to the lateral and dorsal surfaces of the navicular, third cuneiform, and proximal portion of the medial metatarsals. In the horse (Sisson, 1911) it is called the dorsal or oblique ligament. In the deer, however, there is a separate and distinct dorsal ligament, and the one attached to the medial surface of the astragalus will therefore be called the astragalotarsal ligament. The literature on the tarsal ligaments in carnivores indicates that the astragalotarsal ligament is absent in this group. The well-developed calcaneonavicular ligament of the dog has some fibers attached to the medial surface of the astragalus, suggesting that the astragalotarsal has been differ-

entiated from it. The stress at the transverse tarsal joint, in the artiodactyl foot, particularly during dorsiflexion, is undoubtedly the cause for the differentiation of this ligament with its astragal attachment. It aids in preventing dislocation at the transverse tarsal joint along with the dorsal ligament, particularly during dorsiflexion. In the horse the dorsal or oblique ligament serves the same purpose.

There is a rather well-defined ligament in the artiodactyls running from the distal posteromedial corner of the tibia to the posterior corner of the medial trochlear crest. It is closely associated with the sheath of the deep digital flexor. This ligament is here named the posterior astragalotibial ligament and its functions, along with the astragalofibular and astragalotibial ligaments, in preventing dislocation at the upper ankle joint.

The dorsal ligament of the artiodactyl tarsus extends from the anterior or dorsal surface of the astragalus to the cuboid, navicular, and, in the deer, to the proximal portion of the metatarsals. It is not so well developed in the dog, although a small triangular ligament extends from the dorsolateral portion of the astragal neck to the cuboid and cuneiforms. The dorsal ligament is taut when the astragalus assumes a vertical position, and it assists in preventing dislocation at the transverse tarsal joint.

The joint capsule on the posterior portion of the tarsus extends from the dorsal surface of the tuber at the edge of the sustentacular facet to the posterior rim of the tibial trochlea. It is responsible, at least in part, for limiting the outward rotation of the astragalus and is taut only during the last phase of dorsiflexion.

The interosseous ligament, running between the astragalus and calcaneum in the sinus tarsi, is absent in the artiodactyls. In the dog it not only binds these two bones together, but acts as a pivot about which the inversion-eversion movement at the lower ankle joint takes place. In the perissodactyls it is relatively large and assists in preventing movement at this joint.

Although the extrinsic and intrinsic

musculature of the foot has not been particularly considered in this study, it is of equal importance in maintaining the integrity of the various tarsal joints and especially the equilibrium of the entire foot.

The musculature actively participates in overcoming the effect of gravity, which, if unhindered, would cause rotatory movements at all the tarsal joints, resulting in a collapse of the foot.

THE ORIGIN OF THE ARTIODACTYL TARSUS

As the most significant changes in the development of the artiodactyl tarsus occurred in the astragalus and calcaneum, these elements have been selected for further consideration by means of the deformed coordinate method. It is of course possible, by direct comparison of these elements in *Claenodon* and a primitive artiodactyl, to visualize in a general way the transformation into the artiodactyl type. To do this in greater detail, Colbert's (1941) modification of D'Arcy Thompson's deformed coordinate method has been employed.

Briefly, the method involves superimposing, on an orthogonal projection drawing of a given part of an organism, a system of rectangular coordinates. The most primitive known stage of this part should be selected, and an aspect chosen that will show to best advantage the important changes in proportion. The coordinate system is oriented on the drawing so that the points resulting from the intersecting lines are located as nearly as possible about or in important anatomical features. On a similar aspect of the derived form, homologous points are determined as accurately as possible. These points are then connected by lines that include within the deformed coordinate system thus formed areas roughly homologous to given rectangular areas in the primitive type.

This procedure is open to several criticisms besides those discussed by Huxley (1932) which mainly apply to ontogenetic differential growth. The first, already noted by Simpson and Roe (1939), is the impossibility of determining exactly homologous points and areas in the derived form or forms. The second is the error caused by a change in the plane or angulation of the articular facets or other important anatomical features in the de-

scendant. This results in a foreshortening of certain areas in the projection drawing which will, of course, influence the position of the deformed coordinates. In spite of these faults, there is little question but that the method is valuable in making an analysis of the differential phylogenetic growth changes in parts of organisms that permit, by virtue of their conformation, such graphic treatment.

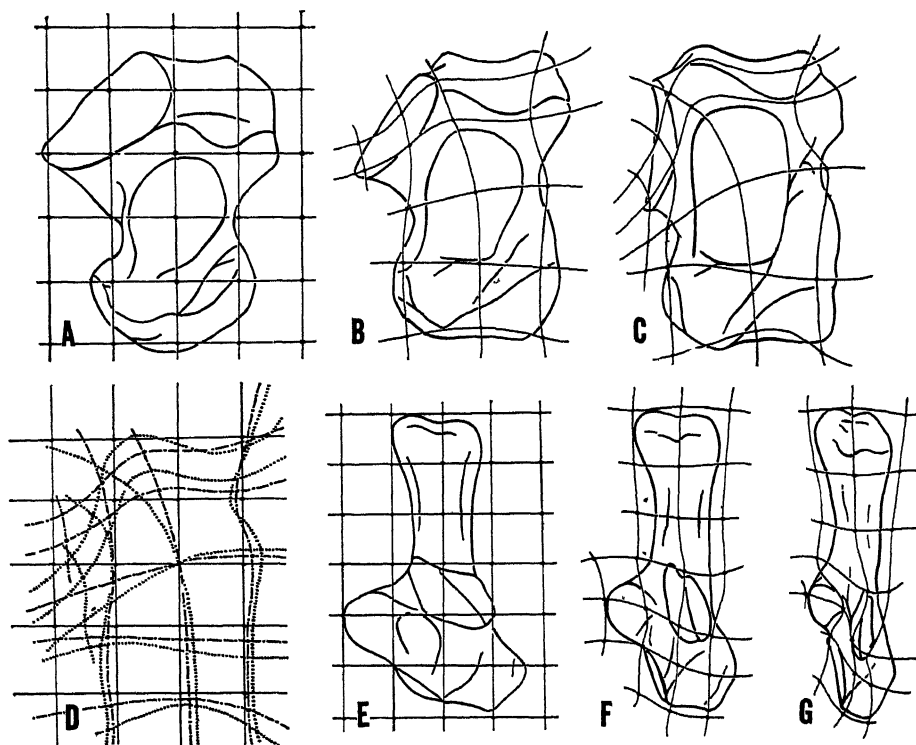
D'Arcy Thompson also devised a method for determining the form of a hypothetical intermediate stage between a primitive and a more specialized derived type. The validity of such a procedure is clearly demonstrated by his study of the evolution of the horse skull (Thompson, 1942). One possible objection to Thompson's method is that the more or less accurate determination of homologous points in the derived forms is apparently sacrificed in order to produce a coordinate system that shows the differential growth changes by means of uniformly curved lines. While the changes are thus indicated in a rather gross manner, the important localized deformations are usually ignored. The virtue of Colbert's modification lies in the consideration of the smaller deformations in locating the homologous points.

The determination of an intermediate coordinate system when the localized deformation is taken into account introduces additional complications. By making the assumption that all differential expansion occurred around a single arbitrarily selected point, the location of which did not change, it is then possible to superimpose the known deformed coordinate system on the rectangular with these particular points coinciding exactly and with the horizontal and vertical coordinates as nearly parallel as the deformation permits. All homologous points of the two systems are then connected by a line, and a new

point is located midway on this line. By connecting the new series of points, a third coördinate system is produced which is in virtually all respects intermediate between the other two (fig. 7D). On the system thus formed, it is possible to outline the hypothetical intermediate stage.

As has been pointed out by several authors, this method cannot elucidate any

The ventral aspect of the astragalus in *Choeroclaenus* and *Diacodexis* and the dorsal aspect of the calcaneum in *Claenodon* and *Oreodon* were selected for deformed coördinate treatment as they show the important changes in both the lower ankle joint and the transverse tarsal joint (fig. 7). The transformation thus depicted produced, as its major contribution, an as-



† Fig. 7. Determination, by the use of the deformed coördinate method, of hypothetical intermediate stages (B, F) between the ventral aspect of the astragalus of *Choeroclaenus* (A) and *Diacodexis* (C) and the dorsal aspect of the calcaneum of *Claenodon* (E) and *Meryocchoerus* (G). In D the grids of A (solid line) and C (dotted line) have been superimposed to demonstrate the method of determining the intermediate grid (dot-dash line) that forms the basis for B.

of the causative factors involved in the transformation of a primitive to a derived type, but it does present a graphic picture of the differential growth changes that probably occurred, assuming harmonious growth rates for all parts concerned. Furthermore, no claim can be made for the complete accuracy of the intermediate stage, although its similarity to an actual transitional stage is highly probable.

tragalus that is mobile only in the vertical plane.

The change in the relative size and orientation of the astragalocalcaneal facet is certainly the most obvious and probably the most radical transformation. In the astragalus, its longitudinal axis swings from a 40-degree angle with the long axis of the entire bone to one essentially parallel. As this rotation progressed, the sur-

face of the facet became directed more laterally and vertically than in the primitive ferungulates. It would appear that the approximate topographical center of this facet acted, so to speak, as a sort of pivot of differential growth, with the proximal portion of the facet swinging laterally and "pulling" the entire proximal end of the astragalus in this direction. The distal end of the facet, swinging medially, made the two sides of the astragalus more or less parallel. A similar rotation of the astragalocalcaneal facet occurred on the calcaneum, with the longitudinal axis of the facet swinging from a 45-degree angle with the long axis of the entire bone to a parallel position. The face of the facet also became more vertical, in accord with the similar change in the astragalar counterpart. The fibular facet on the calcaneum underwent the same reorientation as the astragalocalcaneal.

The sustentacular facet was enlarged, changed in shape from a round to a long oval, and reoriented from a position with a decided medial tilt to an essentially right-angle one. As in the case of the astragalocalcaneal facet, the long axis of this articular surface, by the beginning of the artiodactyl stage, was aligned parallel to the long axis of the astragalus. With the gradual disappearance of the interarticular sulcus, the facet expanded laterally and proximally to the ventral border of the tibial trochlea.

The marked mediolateral compression of the calcaneum in the artiodactyls was brought about largely through a migration of the sustentaculum laterally until it abutted against the proximal end of the tuber. This change occurred simultaneously with the reorientation of the astragalocalcaneal facet. The sustentacular facet became directed more distally than dorsally, a reorientation associated with the change in the posture of the foot from probably semiplantigrade to true digitigrade (as pointed out earlier, the dichobunids probably had five toes on the hind foot).

In agreement with the change in direction of the other subastragalar articulations, the distal astragalar facet was re-

oriented to a position almost parallel with the long axes of the astragalus and calcaneum. This was brought about with the mediolateral compression of the calcaneum. There was, in addition, a reduction in the size of the peroneal tubercle to a slight swelling, probably associated with a decrease in the functional importance of the peroneus longus as an evertor of the foot.

With the gradual alteration in the alignment of the distal astragalar facet, there was a change in the position of the axis of the lower ankle joint. In the primitive ferungulate this axis made an angle of roughly 35 degrees with the longitudinal axis of the astragalus, while in the artiodactyl it is about at a right angle to this axis. This shift in the location of the axis represents a transition from an eversion-inversion motion at the lower ankle joint to a fore-and-aft rotation. The probable location of the transverse tarsal joint axis in the hypothetical intermediate suggests a compromise between these two types of motion, and the transition from one to the other is not difficult to visualize in the functional models. The lagomorphs (Virchow, 1928) and rodents have independently developed an articulation at the lower ankle joint that permits, along with the usual inversion-eversion motion, a limited degree of vertical astragalar rotation. The astragalar head, although not trochleated, is anteroposteriorly rounded. The astragalocalcaneal facet is very large, however, and there is a strong interosseous ligament. This arrangement suggests the manner in which the functional change at this joint may have occurred with the intermediate stage represented by a compromise between an essentially horizontal and a vertical movement of the astragalus. The lower ankle and transverse tarsal joints in certain of the Litopterna, particularly in the Proterotheriidae, also suggest a tendency towards the artiodactyl condition (Ameghino, 1905).

The development of the trochleated head on the astragalus was accomplished by a gradual "squaring off" of this area, particularly on the lateral side, thus increasing the amount of contact with the cuboid. This occurred coincidentally with the nar-

rowing of the calcaneum and a reduction in the area of contact of the calcaneum with the cuboid. As stated earlier, the axis of the transverse tarsal joint probably permitted only dorsiflexion and plantar flexion in the primitive ferungulate, and that is the only motion possible in the artiodactyl. The formation of the distal astragalar trochlea and the reduction of the saddle-shaped calcaneocuboid articulation to a relatively simple sliding joint greatly increased the amount of possible movement.

There was relatively little change in the tibial trochlea of the astragalus except for a deepening of the trochlear groove, and the development of more vertical lateral and medial surfaces, resulting in a tighter articulation with the malleoli, particularly the medial one which also articulates with the calcaneum. The greater curvature of the medial trochlear crest was already present at the *Claenodon* stage and is found in most mammals.

Both Wortman (1901) and Gregory (1910) have considered the tarsus of the mesonychid creodont *Dromocyon* to be in many respects structurally ancestral to the artiodactyl type. Such a conclusion is based on the presence, in *Dromocyon*, of the deep astragalar trochlea, the oblique position of the astragalar head in relation to the body, the astragalocuboid articulation, the broadly oval sustentacular facet,

and the anteroposteriorly convex navicular facet. Comparison with the hypothetical intermediate stage arrived at in this study suggests that, at best, the *Dromocyon* tarsus is representative of only a very early stage in the development of the artiodactyl type. There is, for instance, no indication in *Dromocyon* of any of the basic changes in the astragalus such as the re-orientation of the astragalocalcaneal facet or of the narrowing of the body of the calcaneum.

The final result of this transformation was a different relationship between the astragalus and calcaneum. In the primitive ferungulate the astragalus rested essentially on top of the body of the calcaneum, and part of the body weight was transferred directly to the calcaneum. In the artiodactyls, with a greater elevation of the heel from the ground, the body weight is transferred directly from the astragalus to the navicular and cuboid rather than partly through the calcaneum. Coincidentally with this change in weight distribution in the foot, the mediolateral compression of the calcaneal head occurred, with the final result that the calcaneum could function only as a portion of the socket in which the astragalus rotated and, of course, through the tuber as a lever arm during plantar flexion.

THE FUNCTION OF THE ARTIODACTYL TARSUS

A study of the function of the artiodactyl tarsus involves two interrelated problems, the mechanics of the tarsus itself and an evaluation of the mechanical advantage, if any, of the double-trochleated astragalus over the usual mammalian type. Unfortunately, neither question can be answered completely or conclusively until further experimental work is done on a series of living carnivores and ungulates.

The only attempt of which the writer is aware at making a mechanical analysis of the artiodactyl tarsus is that of Kripp (1935). This study centers on a discussion of the forces at work during astragalar rotation in dorsiflexion only. Kripp is of

the opinion that this rotation is caused by one force acting through the calcaneum and a second force, acting in the opposite direction, through the navicular (fig. 8A). In side view, the astragalus is essentially an ellipse or, to carry the analogy further, a cam-like structure that rotates in a socket formed by the calcaneum, navicular, and cuboid. According to this concept, the axis of the cam (that of the transverse tarsal joint) being eccentrically located, a slight amount of rotation about this axis produces a measurably greater amount of movement of the proximal portion of the astragalus. On this basis, Kripp considers the independent motion of the astragalus as representing a velocity mechanism, and

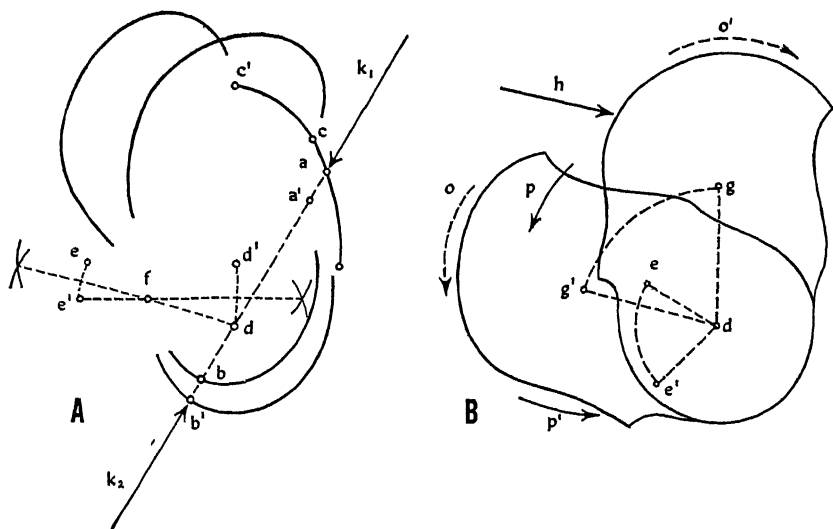


Fig. 8. A. Mechanics of astragalar rotation based on a modification of Kripp's diagram. The axis of the lower ankle joint (e) is probably not correctly located (see fig. 3b). Abbreviations: a-a', displacement of calcaneum; b-b', displacement of navicular; c-c', extent of astragalar rotation; d-d', displacement of axis of transverse tarsal joint; e-e', displacement of axis of lower ankle joint; f, compromise axis of transverse tarsal and lower ankle joints; k₁, force exerted by calcaneum on astragalus at astragalo-calcaneal facet; k₂, force exerted by navicular on astragalus at trochleated head. B. Rotation of the astragalus about the axis of the transverse tarsal joint (d) producing a cam-like action and resulting in a displacement of the axis of the upper ankle joint from g to g', the velocity effect described by Kripp. While movement at the lower ankle and transverse tarsal joints occurs simultaneously, these articulations have distinct axes of rotation, and there is no evidence that a compromise axis is involved. The forces causing fore-and-aft rotation of the astragalus are primarily due to the contraction of the extrinsic extensor and flexor muscles of the foot, acting through the tibia and the ligaments running between the tibia and the astragalus. Other abbreviations: e-e', displacement of lower ankle joint; h, force exerted through tibia producing astragalar rotation during plantar flexion; p and p', forces exerted through tibia and astragalotibial plus astragalofibular ligaments producing astragalar rotation during dorsiflexion; o, direction of movement during dorsiflexion; o', direction of movement during plantar flexion.

he concludes that this action is the functional basis for the unique structure of the artiodactyl tarsus.

Kripp's rather involved analysis of the forces producing astragalar rotation during dorsiflexion is based on the assumption that the astragalus is forced to rotate by the forward and downward movement of the calcaneum. During dorsiflexion, however, the contraction of the extrinsic extensors of the foot cannot act on the calcaneum, and presumably during this phase the flexors are relaxed. Outward astragalar rotation (clockwise when observed from the lateral side of the foot), therefore, can only be caused by, and as a result of, the dorsiflexion of the foot on the tibia. It is of course possible that a velocity effect is

present during both dorsiflexion and plantar flexion.

As pointed out above, Kripp does not specifically consider the movement of the astragalus during plantar flexion (extension) of the foot, and he may have confused the forces at work during the two phases of the locomotor cycle. When the extrinsic flexors are contracting during plantar flexion, pressure is applied against the astragalus by the calcaneum, and as a consequence an equal amount of pressure is also applied in the opposite direction by the cuboid and navicular. During this phase, however, the astragalus is rotating back into its socket (counter clockwise motion when observed from the lateral side of the foot). Hence the astragalus

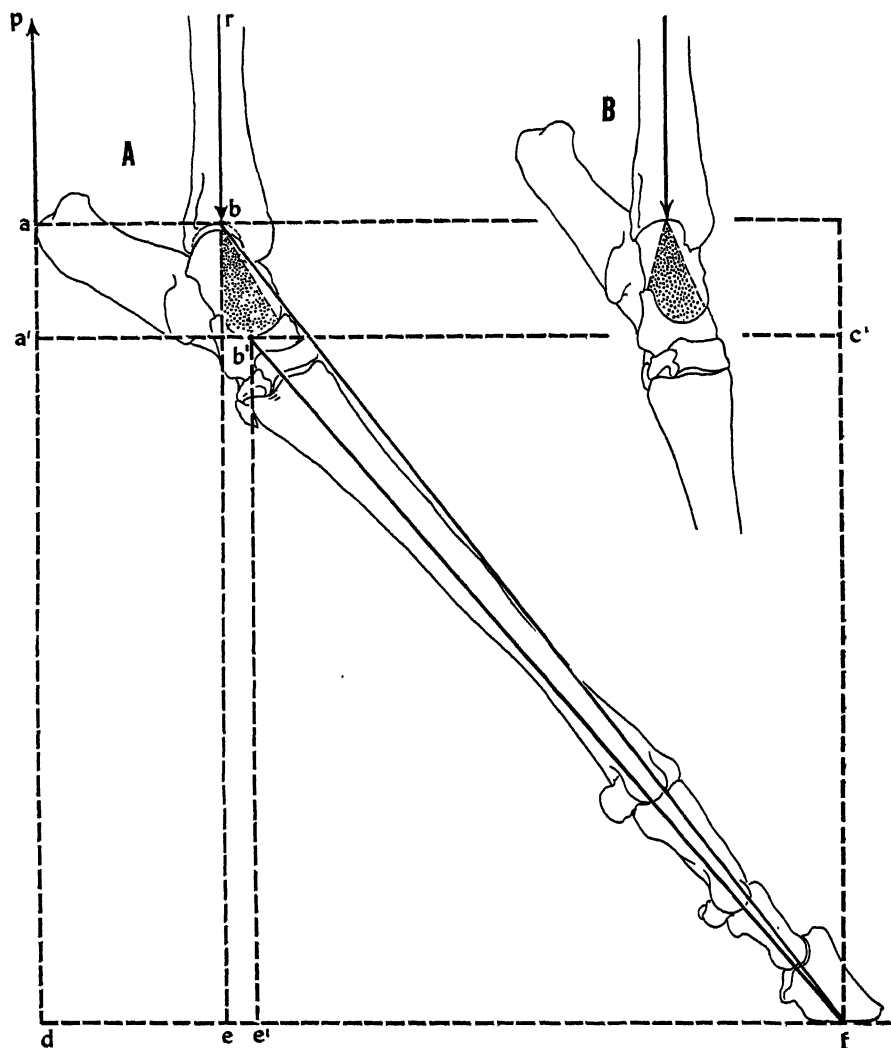


Fig. 9. A. Artiodactyl hind foot in approximate position assumed at beginning of propulsive phase of locomotor cycle. Stippled area on the astragalus represents the weight distribution in this element from the point of application of the resistance *b*. Details of figure explained in the text. B. Approximate position of foot at the end of the propulsive phase. Area indicating weight distribution shows virtually no change from beginning of this phase.

is moving against the forces that Kripp claims cause outward rotation and it is moving not clockwise but counterclockwise.

Manipulation of a pig hind limb with only the skin removed demonstrates that contraction of the flexor musculature, although it brings into play the forces described by Kripp, does not inhibit the counterclockwise rotation of the astrag-

alus. In fact, approximation of the tibia and calcaneal tuber during plantar flexion results in such a movement (fig. 5). Both the dissected specimens and the X-rays demonstrate that the movement at the transverse tarsal and lower ankle joints during plantar flexion is almost completed before that at the upper ankle joint is clearly under way.

During part of plantar flexion, before the foot hits the ground to begin the propulsive phase, the astragalus is therefore a functional part of the tibia. This situation is apparently due to the low angle of application of the crural flexors in relation to the upper ankle joint, for the tibia simply pushes against the astragalus, with the result that rotation occurs only at the transverse tarsal and the lower ankle joints (fig. 8B). By the start of the propulsive phase, an essentially right-angle relationship has been established between the calcaneal tuber and the tibia, and movement at the upper ankle joint is initiated. Hence the double-trochleated astragalus may be considered as a means of rapidly and efficiently increasing the angle of application of the crural flexor musculature when the foot is in a position of extreme dorsiflexion. This arrangement undoubtedly assists in the development of great initial propulsive power by the time the foot is in contact with the ground.

In the generalized mammalian foot, with dorsiflexion and plantar flexion restricted to the upper ankle joint, the effort and resistance moments operate about a single axis. The foot is therefore considered to be a lever of the first class during the propulsive phase (Gregory, 1912; *et al.*), and the fulcrum is represented by the contact of the tibia with the astragalus. In the artiodactyl tarsus, however, two fulcra are probably present, one (b) at the upper ankle joint and the other (b') at the transverse tarsal joint (fig. 9). The slight amount of movement occurring at the transverse tarsal joint after the foot touches the ground is sufficient to consider this articulation as the location of a true fulcrum. By referring to figure 9, it is evident that the power component a'b' operating about this fulcrum is greater than the component ab associated with the fulcrum at the upper ankle joint and also that the resistance component b'c' is smaller than bc. It would appear, therefore, that at the beginning of propulsion when the resistance to continued plantar flexion is at a maximum, the optimum lever arrangement is in operation. Movement at the upper ankle joint very quickly follows, however, and the

shorter power component ab becomes effective. As the foot becomes more vertical, resulting in a decrease in resistance, the power components ab and a'b' also decrease. The contraction of the flexor musculature is, of course, of primary importance in this connection. Gray (1944) has shown that the elevation of the heel from the ground results in a decrease of the strain on the extrinsic flexor musculature. This reduction is proportional to the distance between the ankle joint and the vertical force exerted by the body. This force passes vertically through the foot in the region of the phalanges. A. Fick in 1867 pointed out that a mechanical arrangement which permits a decrease in the resistance component during muscular contraction also increases the actual work performed by that muscle. It would appear that the power component ab is the last to operate, as movement at the transverse tarsal joint apparently is concluded before that at the upper ankle joint. The exact sequence of movement at these articulations is difficult to determine, however, on the basis of available evidence.

The femorotibial and femorometatarsal indices of the more primitive artiodactyls fall within the range of the larger predatory carnivores (Gregory, 1912; Howell, 1944), although the highly cursorial artiodactyls have the highest indices among mammals. This similarity in the ratios of the primitive artiodactyls and the carnivores would place a high premium on the efficiency of the artiodactyl tarsus as a means of increasing speed or producing a great initial thrust at the beginning of the propulsive phase of the locomotor cycle. In this connection, the velocity mechanism of the astragalus would play an important role in speeding up the recovery phase and in giving the body a greater forward thrust during propulsion.

The value of the cursorial habitus in any ungulate depends largely on its functional efficiency when the animal is forced to move at high speed to escape an enemy and is, therefore, essentially a mechanism of passive defense. Laboratory tests on living artiodactyls indicate a somewhat greater range of movement in the foot than is pos-

sible in the carnivores, and there is evidence of this in Muybridge's photographs. It is probable, however, that none of the artiodactyls used in these studies were moving at their maximum rate of speed or with maximum stride, with the exception of the leaping fawn (Muybridge, 1899, p. 193) which shows very clearly extreme dorsiflexion and plantar flexion of the hind limbs. In any case, a slight increase in the range of movement plus the velocity effect during astragalar rotation and, finally, in the more advanced artiodactyls, the increased limb ratios are all factors making for greater speed and greater initial momentum during propulsion.

The perissodactyl tarsus presents a very different picture. Both manipulation of the partly dissected specimens with the ligaments *in situ* and the X-rays (fig. 4C) indicate that no appreciable movement occurs at either the lower ankle joint or the transverse tarsal joint. Dorsiflexion and

plantar flexion are therefore confined to the upper ankle joint, and there is no indication that the range of motion at this joint is significantly greater than in the carnivores or artiodactyls. It would appear, therefore, that the cursorial perissodactyls such as the primitive rhinoceroses and the horses were dependent, as far as the hind limbs are concerned, upon the increased femorotibial and femorometatarsal ratios for greater speed.

Both Kripp (1935) and Howell (1944) compare the gaits in perissodactyls and artiodactyls, and this phase will not be discussed here. It should be mentioned, however, that the lightly built artiodactyls have a definite leaping stride during the fast gallop. Certain antelopes, according to Howell, may cover as much as 40 feet in a single bound. The ability to cover such a long distance in a single stride is undoubtedly associated, at least in part, with the design and function of the tarsus.

SUMMARY

1. The definitive artiodactyl tarsus as it first appears in Lower Eocene deposits represents the abrupt introduction of a basic ordinal character. There are no known intermediate or transitional stages between this tarsus and the presumed ancestral type. Predator pressure must have been an important factor in the apparent rapid evolution of this structure, which had virtually reached the biomechanical limit of specialization by the Lower Eocene.

2. Available evidence indicates that the artiodactyls evolved from the primitive hyposodontid condylarths, although the tarsus of these early ferungulates is very similar to that of the artocyonid creodonts. In these types, the astragalus has a shallow tibial trochlea, a wide interarticular sulcus, and a rounded head. The calcaneum has a well-developed interosseous fossa and a robust sustentaculum supporting, in part, the astragalus.

3. The axes of the upper and lower ankle joints and the transverse tarsal joint have been determined for the artocyonid creodont *Claenodon*. These axes are oriented in several different planes, suggesting

the condition occurring in the tarsus of the chimpanzee and man, which may be close to the generalized eutherian arrangement. The probable motion at each of these joints is discussed.

4. The primitive artiodactyl tarsus differs markedly from the generalized ferungulate type. The astragalus has a deep tibial trochlea, the interarticular sulcus has disappeared in connection with a reorientation of the astragalocalcaneal and sustentacular facets, and the head is trochleated. The calcaneum has lost the interosseous fossa, and the sustentaculum no longer offers direct support to the astragalus.

5. The axes of the three ankle joints have been worked out for *Ovis*. With the changes in the astragalus and calcaneum noted above, these axes are now oriented in such a manner as to permit rotation of the astragalus in a vertical plane. This motion is demonstrated in a series of X-rays of the foot of a living goat.

6. The ligaments of the artiodactyl tarsus have been modified to permit vertical astragalar rotation. The fibers of the

calcaneotibial and superficial calcaneal ligaments are somewhat spiraled in order to maintain effectively the integrity of the ankle joint during this rotation.

7. The transformation of the artiodactyl astragalus and calcaneum from the *Claenodon* type is described in detail by the use of the deformed coördinate method. The limitations of the method are discussed.

8. An attempt is made to describe the

function of the artiodactyl tarsus, particularly in relation to astragalar rotation. The astragalus is essentially a cam-like structure that may be considered as a velocity mechanism. It also aids in increasing the angle of application of the crural flexor musculature at the start of the propulsive phase when two tarsal fulcra are probably present, at the upper ankle joint and the transverse tarsal joint.

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A NEW EOCENE MARSUPIAL FROM BRAZIL

BY GEORGE GAYLORD SIMPSON

INTRODUCTION

Until recently mammals of probable Eocene age had been known in South America only from Argentine Patagonia.¹ There has been no knowledge as to how widespread these faunas may have been in South America or how representative the Patagonian collections may be with respect to the continent as a whole. The discovery of identifiable Eocene mammals in Brazil is therefore a paleontological event of the first importance. This discovery was announced recently by L. I. Price and C. de Paula Couto.² Those authors have also prepared a more detailed and illustrated account of these fossil mammals, which was presented to the Second Pan-American Congress of Mining Engineers and Geology and is now in press in the proceedings of the congress.

Among the fossils obtained from this deposit were two of such exceptionally difficult sort of preservation that they could not adequately be prepared and studied with the technical facilities and comparative materials available in Brazil. It was therefore arranged that these specimens be sent to the American Museum of Natural History in New York. One of the

specimens was disappointing because on preparation it proved to be a jaw fragment of an animal so young that the teeth were unerupted and had not yet calcified sufficiently to preserve an identifiable pattern. The other specimen is the identifiable and important fossil described in the present paper.

The specimens were found by the engineers in charge of a limestone quarry near Itaboraí and were given to Prof. Julio Magalhães of the Faculdade Nacional de Filosofia, in Rio de Janeiro. He transmitted them to Dr. Carlos de Paula Couto of the Museu Nacional do Rio de Janeiro, who in turn arranged for their delivery to the American Museum and for my study of them. The specimens were prepared by Mr. George O. Whitaker of our laboratory, and the drawings accompanying this paper, requiring unusual skill in accurate interpretation of the difficult material, were made by our staff artist, Mr. John C. Hermann. I am deeply indebted to all these gentlemen.

This paper is first being published in English by the American Museum, and it is planned subsequently to publish a Portuguese version through the Divisão de Geologia e Mineralogia do Departamento Nacional da Produção Mineral in Brazil. Plastotypes will be deposited in that division and in the Museu Nacional, in Rio de Janeiro.

¹ A possible exception is *Griphodon peruvianus*, known from a single specimen from Peru. Its age is unknown, but the morphology of the fossil itself suggests that it may be intermediate between Mustersan and Deseadan forms, and this might place it somewhere in the later Eocene.

² Price, Llewellyn Ivor, and Carlos de Paula Couto. 1946. Vertebrados fósseis do eoceno inferior de Itaboraí. Ministério da Agricultura (Brazil), Divisão de Geologia e Mineralogia, Notas Preliminares e Estudos, no. 31, pp. 1-3.

TAXONOMY

ORDER MARSUPIALIA ILLIGER, 1811

Family Didelphidae Gray, 1821¹GENUS *Eobrasilia*,² NEWTYPE: *Eobrasilia coutoi*, new species.

KNOWN DISTRIBUTION: Eocene of Brazil.

DIAGNOSIS: A marsupial of generally didelphid aspect, with some resemblance to the most primitive borhyaenids. Canine large. P¹ minute, one-rooted. P² intermediate, and P³ very large and heavy. M³ apparently ovoid in outline, without strong or angulate styler projections. Nasal, lacrimal, frontal, and maxilla meeting, or nearly meeting, at a single

point. One pair of relatively very small palatal vacuities.

Eobrasilia coutoi,³ new species

TYPE: A.M.N.H. No. 39424, incomplete facial part of skull.

HYPODIGM: Type only.

HORIZON AND LOCALITY: Eocene, probably Casamayoran, fresh-water limestone in a cement quarry on the ex-fazenda of São José, near the city of Itaboraí, Município de Itaboraí, Estado do Rio de Janeiro, Brazil.

DIAGNOSIS: Sole known species of the genus.

DESCRIPTION

The specimen consists of much of the facial part of the skull, but badly broken and incomplete. What remains is peculiarly confusing, and its interpretation is difficult. The premaxillary region is lacking. The upper part of the left maxilla is present, but its alveolar portion is completely gone, and the palatal part is represented by its internal mold on the matrix. The facial part of the right maxilla is represented by the internal mold. The alveolar process is represented only by a fragment in the premolar region. Much of the palatal part is present, but the anterior end is missing. The posterior ends of the nasals and the anterior parts of the frontals are fairly well preserved. Much of the left lacrimal is present, but it is flaked and eroded. The anteromedial part of the right palatine is present, and the posterior nasal, or choanal, passage is represented by an internal mold. A separate piece of matrix preserves the mold of the ventral palatal surface, except the extreme anterior end, and has traces of impressions of the cheek teeth, which have made possible the counting and orientation of these.

All the cheek teeth were apparently present as the skull was buried, but most

of these were lost when the rock was cracked open, revealing the specimen. Five teeth were preserved, and it has been possible to place these as right P¹⁻³ and left P³ and M³. All are worn, and M³ is badly crushed and broken. The teeth do not make contact on the skull fragment, but with the help of the external palatal mold their exact positions could be determined, and they have been mounted on wires in the correct places on a cast of the palate.

The animal was about as large as a robust *Didelphis virginiana*, and the general aspect of the preserved part of the face is similar. There is a relatively broad, subquadrate frontal table, slightly depressed at the midline. The snout narrows moderately anterior to the orbits, and the dorsal nasal contour is nearly a straight line, sloping downward anteriorly.

The nasals are long, their median posterior point at a level about midway between the anterior orbital rim and the postorbital process. In *Didelphis* they are usually still longer and in *Dasyurus* slightly shorter, but both families include forms with the nasals of about the same relative length as in the fossil. Known borhyaenids include almost the whole didelphid-dasyurid range in this respect. The nasals come to a somewhat rounded median point posteriorly, and

¹ Or possibly Borhyaenidae Ameghino, 1894; see discussion of affinities.

² The generic name is meant to suggest an Eocene fossil from Brazil. It does not have reference to the genus *Brasilia*, a mollusk, with which confusion is hardly possible.

³ Named in honor of Carlos de Paula Couto.

anterior to this, near the level of the anterior orbital rim, they are considerably expanded laterally. The sutures here are complex and somewhat eroded on the fossil, but it appears that nasal, lacrimal, maxilla, and frontal all meet, or nearly so, in a common point. This is a distinctly didelphid character. In dasyurids the frontal and maxilla meet broadly, separating the nasal and lacrimal. In borhyaenids the nasal usually meets broadly with the lacrimal and separates maxilla and frontal. In *Arminiheringia*, however, naso-lacrimal contact is short. This part of the face is not known in other very early or in the most primitive borhyaenids. They probably were near the didelphid condition in this region, and it is distinctly possible that primitive borhyaenids here resembled *Eobrasilia*. Among later borhyaenids, *Borhyaena* typically has a well-established naso-lacrimal contact, but in Princeton No. 15120 this is probably no longer than in *Eobrasilia*.

The median nasal suture is still visible and partly open, but had begun to fuse.

The frontals are fully fused at the midline, as is usual in adult marsupial carnivores. The extent of development of the diverging anterior branches of the sagittal crest cannot be determined. There is a short, blunt postorbital process as in *Didelphis* and most comparable forms.

The lacrimal, poorly preserved, seems to have had about equal facial and intra-orbital parts, although the latter may have been somewhat larger, as is usual in comparable later marsupials. The foramen cannot be made out with certainty, but it was apparently on the orbital rim, much as in *Didelphis*. In dasyurids it is usually facial and in borhyaenids usually intra-orbital, although *Arminiheringia*, again, resembles *Didelphis* in this respect.

As far as preserved, the maxilla is not distinctive, except for the posterolateral relationships, already discussed. The internal mold is comparable point for point with an internal mold of *Didelphis*, aside from slight changes of proportion or sharpness of various features. Dasyurids seem, however, to be equally similar, and no de-

fined borhyaenid internal mold of this region is available.

The palatines are broadly expanded on the palate and reach forward at the midline to approximately the level of the anterior side of M^2 . The width of the palatines between M^4 was approximately 13 mm. At the anterolateral corners of the palatines, between them and the maxillae, are small vacuities, that on the right side about 3 mm. in length and that on the left about 7 mm. Although there is great variation in the vacuities in these families, it is normal and, apparently, primitive for didelphids and dasyurids to have relatively much larger vacuities in this position. The fossil lacks the second, smaller, more posteromedian pair of vacuities within the palatines usual in didelphids. As far as known, definitely referable borhyaenids have no vacuities, although it cannot be doubted that they were derived from forms with vacuities and that vacuities may have occurred in their most primitive representatives. The present fossil definitely, although not conclusively, suggests a trend from didelphids to borhyaenids in this respect. Little can be made out of the posterior and posterolateral rims of the palate, but the posterior rim was apparently thickened and raised and the posterior palatine foramina were evidently present and in the usual position—in different didelphid or borhyaenid characters. On the palatal mold may be seen what appears to be the palatine-pterygoid suture, which is more vertical and more anterior than usual in comparable forms, but this is not certain or clearly significant.

No evidence as to the incisors is available.

On the left side the upper part of a canine alveolus is visible, with the end of the canine root still present. At this point, where the root would be at or slightly below its greatest size, the maximum diameter is about 6 mm. and the minimum diameter 3.5 mm. This indicates a moderately compressed, lanian canine relatively nearly as large as in *Didelphis* or some of the more primitive borhyaenids. Judging from the facial swelling over it, the alveolus extends

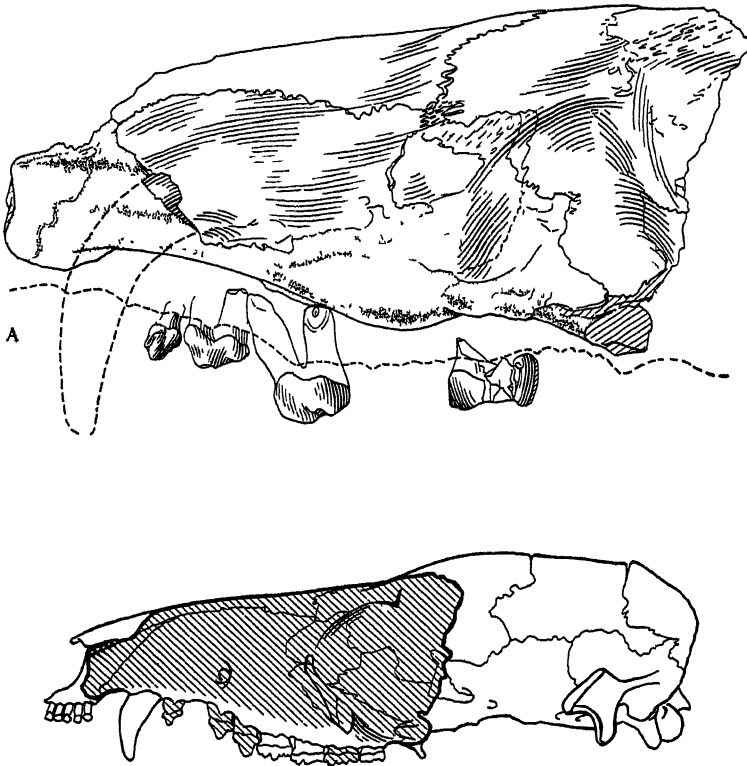


Fig. 1. A. *Eobrasilia coutoi*, new genus and species. Type, A.M.N.H. No. 39424, incomplete facial part of skull. Left lateral view. P^1 ^{2} are reversed from the opposite side. The teeth are shown in their approximate natural positions, although they do not make contact with the rest of the specimen, and the alveolar border is not preserved. Parts shaded with lines have bone surface preserved. Parts shaded with dots are matrix, preserving a natural internal mold of the missing bones. $3/2$ natural size. B. Sketch of skull of *Didelphis* with cross hatching, indicating parts homologous to those preserved in the type of *Eobrasilia coutoi*. The zygoma is shown as cut away. $3/4$ natural size.

far up the face, almost to the maxillo-nasal suture.

P^1 is a tiny tooth with the base of the crown 3.7 mm. in its longest and 2.2 mm. in its shortest diameter. It is implanted by a single, slender root and is turned so that the longest dimension, normally anteroposterior, is anteroexternal-postero-internal. It has a somewhat procumbent main cusp, preceded by a small accessory cuspule and followed by a slightly larger but lower heel. The outer face is smoothly convex, the inner somewhat excavated.

P^2 is a considerably larger tooth, 5.8 mm. long and 3.6 mm. wide, implanted by two roots, and normally oriented. The

outline is ovoid, and the posterior part, especially, is unusually heavy. It is deeply truncated by wear, the plane of which dips sharply upward posterointernally. The main cusp is preceded by a very small accessory cuspule and was apparently followed by a well-differentiated heel.

P^3 is strikingly large and heavy, the crown about 8.5 mm. long by 5.2 mm. wide. (Measured on right P^3 ; left P^3 , as preserved, is shorter, but this is probably influenced by wear.) This tooth also has two roots and normal orientation. It is even more deeply worn than P^2 , and the coronal detail is obliterated. In addition to a main wear facet like that on P^2 , the

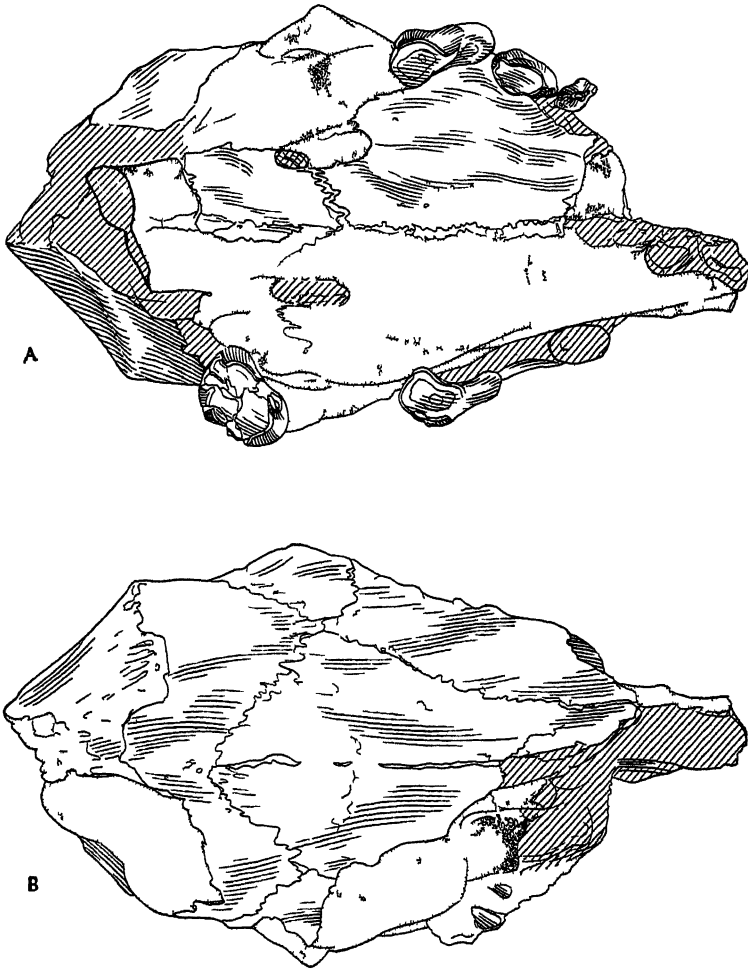


Fig 2 *Dobrasilia coutoi* new genus and species Type, A M N H No 39424 incomplete facial part of skull Teeth, not actually in contact with preserved part of skull are shown in their approximate natural positions Parts shaded with lines are preserved bone surface Parts shaded with dots are matrix preserving a natural internal mold of missing bones Parts cross hatched are broken matrix surface A Palatal view B Dorsal view The anterior end is to the right $3/2$ natural size

anteroventral part is worn and broadly grooved On left P^3 , but not right, there is also a small worn notch in the sharp enamel edge external to the main worn facet Just anterosuperior to this notch is a tiny tubercle, not seen on right P^3

M^1 and M^2 are not preserved Obscure traces on the natural palatal mold suggest that M^1 was smaller than P^3 and M^2 slightly larger than M^1

Left M^3 is preserved, but it has been badly crushed and fragmented It may originally have been about 8.5 mm in length and about 9 mm in breadth The anteroexternal and internal margins are smoothly rounded, distinctly less angulate than in known borhyaenids or in didelphids except, perhaps, a few Cretaceous forms The metastylar region is so broken that it is uncertain whether there was a metastylar

spur, but there is no evidence for this, and the whole crown may have been rather smoothly ovoid in outline. The surface is deeply truncated by a nearly horizontal wear facet, and this has obliterated all coronal detail except a small anterior cuspule, near but somewhat lingual to the antero-external point of the crown. Its position is

more or less nominally parastylar, but it does not project as does the first style, or parastyle, of usual didelphids, borhyaenids, or dasyurids.

M⁴ is not preserved. A partial impression on the palatal mold shows that the internal projection was rounded, like that of M³ but apparently somewhat smaller.

AFFINITIES

Eobrasilia is clearly a polyprotodont marsupial and must belong to the Didelphidae, Borhyaenidae, Dasyuridae, or a new family. Reference to the Dasyuridae is unjustified and does not come further into question if separation of Borhyaenidae and Dasyuridae be granted; *Eobrasilia* has no distinctly dasyurid characters in the known parts and does have at least one diagnostically non-dasyurid character: the nature of the naso-lacrimal approach.

The general habitus is that of a robust didelphid or of a very primitive borhyaenid. Aside from the cheek teeth, which are neither didelphid nor borhyaenid in aspect, as discussed below, the known parts are so closely similar in didelphids and in primitive borhyaenids that decision is difficult. There are only two points that might be diagnostic between these families among the known characters of this fossil. The nasal-frontal-lacrimal-maxillar contact is distinctly didelphid as opposed to typical borhyaenids. But the condition is not very different in *Arminiheringia*, an early (Casamayoran) but not particularly primitive borhyaenid or in the later (Santacrucian) *Borhyaena*, and this region is not known in truly primitive early borhyaenids, which might even be expected to resemble *Eobrasilia* in this respect. The presence of palatal vacuities is, again, diagnostic of the Didelphidae as opposed to characteristic and more or less specialized Borhyaenidae, but again this is not conclusive. The vacuities are greatly reduced from the usual didelphid condition (known to have been fully established in the Cretaceous). The small, single pair of vacuities in *Eobrasilia* is, indeed, as near the specialized borhyaenid condition (no vacuities) as the typical didelphid condition

(large vacuities, and often two pairs). Again, this region is not known in truly primitive early borhyaenids, which might be expected to resemble *Eobrasilia* here.

The possibilities of basic borhyaenid affinities must be viewed in the light of the fact that in the Riochican and Casamayoran of Argentina there are several small marsupials that seem, from their teeth, to be intermediate between didelphids and borhyaenids. Pertinence of *Eobrasilia* to such a stock, or derivation from it, is a distinct possibility. These Argentine forms are known from teeth only, which are not much like what is known of the peculiar *Eobrasilia* dentition.¹

Although the aspect of *Eobrasilia* is much like *Didelphis*, it is not like the previously known early or middle Tertiary didelphids of South America, and as between these only and the borhyaenids it is more borhyaenid. These particular didelphids are all microbiotheres, tiny, insectivore-like forms.

What is known of the dentition of *Eobrasilia* is highly peculiar and suggests no particular group of marsupials, although derivation from either didelphids or basic borhyaenids would be possible with moderate subsequent specialization. Lack of knowledge of the coronal molar pattern of *Eobrasilia* is strongly felt, but the enlarged and heavy P³ and the rounded M³ without parastyle or protocone angulation are peculiar features, quite off the lines of later didelphid or borhyaenid trends. *Borhyaena* does, indeed, have P¹ reduced and rotated and P³ enlarged and heavy, much as in *Eobrasilia*. This may well represent

¹ This excludes possible synonymy of *Eobrasilia*. Only one of the Argentine forms in question has been named: *Patene* Simpson, 1935.

a parallel borhyaenid trend, but M^3 in *Eobrasilia* seems to have been quite unlike that of *Borhyaena*. There is some suggestion of habitus resemblance to the North American Cretaceous Thlaeodontinae, which also have heavy P^3 and somewhat rounded molars, but this is not likely to indicate special affinity. The thlaeodontine premolars are more highly and differently specialized than in *Eobrasilia*, and the molar parastyle, the only available detail for molar comparison, is quite different. *Caroloameghinia*, from the Casamayoran of Argentina, is a marsupial with rounded molars, but special affinity with *Eobrasilia* is unlikely. *Caroloameghinia* included very small animals of quite different aspect and with the lower canine, probably also the upper, reduced. Upper premolars are unknown, but the lower premolars would not occlude with upper teeth trending towards *Eobrasilia*

in specialization. For instance, P_3 is, if anything, somewhat reduced relative to P_1 and P_2 .

The somewhat peculiar adaptive type of the known parts of the *Eobrasilia* dentition suggests that it belongs on an aberrant line not otherwise known. More complete knowledge is necessary before deciding how distinctive that line is, whether, for instance, it should be recognized as a separate subfamily.

As a matter of morphological diagnosis the known parts of *Eobrasilia* can enter the Didelphidae, and the genus does not appear to be close to any known borhyaenid. It is therefore now formally, but tentatively, placed in the Didelphidae. I suspect, nevertheless, that it represents a line derived from the earliest borhyaenids or from a didelphid-borhyaenid transition group.

AGE AND OCCURRENCE

Mammals found associated with *Eobrasilia* include *Henricosbornia* and *Trigonostylops*. These genera, previously known only from Patagonia, are there characteristic of the Casamayoran, although *Henricosbornia* also occurs in the late Riochican, and *Trigonostylops* somewhat doubtfully in the Mustersan. The deposit must be ap-

proximately Casamayoran in age. *Eobrasilia* is unknown elsewhere and casts no further light on this correlation. Further details as to the occurrence and the associated fossils are given in the paper by Price and de Paula Couto cited previously and, especially, in their more complete report now in press.

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RESULTS OF THE ARCHBOLD EXPEDITIONS. NO. 58

MOISTURE LOSS IN RELATION TO HABITAT SELECTION IN SOME FLORIDIAN REPTILES

By CHARLES M. BOGERT¹ AND RAYMOND B. COWLES²

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INTRODUCTION

Virtually nothing is known concerning the mechanism of water loss in reptiles. It has been argued (Wetmore, 1922) that any moisture loss is largely through the lungs, since no sweat glands are present on reptiles. However, Noble and Mason (1932) state that moisture may be lost as well as absorbed through the skin of reptiles. Benedict (1932) did not determine how moisture was lost, although he mentions a few bits of evidence bearing on the problem. He also points out that there is rough correlation between carbon dioxide production and vapor output. He found that when the water vapor was measured simultaneously

with the heat produced by a snake in an electrical compensation calorimeter, a large output of vapor was evident, "indicating that the major portion, if not all, of the heat produced by the snake left the body by the path of vaporization of water."

Such evidence indicates that water may be lost through the lungs, as well as the skin. In fact there is evidence that at body temperatures approaching the critical maximum some snakes are able to lower their temperatures a few degrees by accelerated breathing with respiratory cooling, doubtless accompanied by vaporization from the lungs. On the other hand Benedict (*supra cit.*) reports the significant observation that, in spite of the absence of sweat glands, there is an unusually large loss of water vapor in snakes just prior to the shedding of

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Fig. 1. Terrain to the northwest of the Archbold Biological Station near Lake Placid, Highlands County, Florida. Timbering operations in the former Pine Flatwoods have resulted in the removal of most of the trees beyond the railroad track in the foreground. Relatively few reptiles except *Sceloporus woodi*, *Eumeces inexpectatus*, and *Coluber constrictor priapus* occur in such disrupted habitats.



Fig. 2. View to the east of the Archbold Biological Station, showing the scrub forests, with pine and palmetto interrupted by fire lanes. Several species of reptiles occur in this habitat, *Sceloporus woodi* being the most abundant.

the skin. In one of his experiments the water output of a boa about to shed increased from 5 to 11 grams per kilogram of body weight. This may indicate only a temporary loss of water through the skin, a loss that perhaps is more closely associated with the complex physiological processes involved in ecdysis.

Hall and Root (1930) desiccated a few amphibians and reptiles under controlled conditions and found that the amount of water loss was variable, being greatest in the salamander and least in the alligator. Although they tested but one representative of each group, they drew the conclusion that the lower in the phylogenetic series an animal is, the greater is the influence of low humidity upon its temperatures. Noble and Mason (1932), however, point out that there are vast differences between individual species of reptiles belonging to the same suborder. They do not describe the techniques they employed, but they report that lizards absorb moisture through their skin, and that species living in damp habitats both lose and absorb greater amounts of moisture than those frequenting arid regions. Moreover, they state that there is little correlation between water loss and skin structure except that the most

impervious skins are provided with the thickest horny layer.

It is no simple task to determine whether heat is more important than moisture as a factor limiting distributions; optimum conditions for a reptile's activity may indeed be dependent more often upon both, as well as upon other factors. However, it is well known that even in the tropics both amphibians and reptiles are more difficult to find during the dry season than they are at other times of the year, even though there may be no significant drop or rise in atmospheric temperatures. In temperate regions reptiles are not abroad during periods of cold, and relatively few species are abroad during the driest months. In general more species are seen and adult individuals tend to be more abundant, even in deserts, during the wettest periods of the warm months. Whether moisture is lost in greater quantities through the lungs or through the skin, it is of interest to ascertain the differences that may exist among species living in various habitats in the same region. The purpose of these experiments, therefore, was to measure the moisture loss in as many species of Floridian reptiles as possible under conditions that would permit comparisons.

REGION AND TERRAIN

It is important that ecological experiments with reptiles be carried out with freshly captured specimens. Relatively few species can easily be maintained under conditions in captivity that permit them to thrive. Commonly reptiles secured from dealers are emaciated or in such poor physical condition that they are unlikely to survive under experimental conditions tolerated by healthy animals. For this reason it was imperative that experiments be carried out in a region where reptiles could not only be observed in the field, but where they could be transferred immediately to the laboratory. Such requirements were met at the Archbold Biological Station,¹ which is situated 7 miles south of

the town of Lake Placid in southern Highlands County, Florida. For several years over a thousand acres of land (figs. 1, 2) comprising the area controlled by the Biological Station have been relatively undisturbed, although fire lanes have been cut in the vegetation and drainage ditches have been dug at the lower portions of the land. These ditches empty into Lake Annie, a

¹ Much of the cost entailed in carrying out these investigations was borne by the Archbold Expeditions of the American Museum of Natural History. In addition we are greatly indebted to Mr. Richard

Archbold for his hospitality, his innumerable courtesies, and his constant assistance and advice in designing laboratory apparatus, for which he supplied much of the material. For their help in securing live reptiles we are similarly grateful to members of his staff, including Messrs. Frank Rinald, S. H. Walter, Dennis Hinchey, Winston Kelsey, Ben Kline, Melvin Purviss, Thomas Browning, Tom Barnes, and Scofield Williams. Thanks are due Mr. Leonard Brass for his courteous help in drawing up our plans. Dr. A. F. Carr, and Dr. Coleman J. Goin of the University of Florida, as well as Mr. Ross Allen of Silver Springs, all of whom are well acquainted with the herpetofauna of Florida, were extremely helpful in offering suggestions concerning collecting techniques and other information. To them our thanks are gratefully acknowledged.



Fig. 3. Red Hill, at the horizon to the left looking east from the Archbold Biological Station, rises to a maximum elevation of 222.2 feet and marks the southern end of the Highlands Ridge of central Florida. South of this hill the relatively dry ridge drops off abruptly to the Pine Flatwoods, and Wet Prairies of the Everglades. *Rhineura floridana*, *Neoseps reynoldsi*, *Coluber flagellum*, *Coluber constrictor*, *Gopherus polyphemus*, as well as several other reptiles, occur in this habitat.

pond approximately a mile north of the Biological Station. Red Hill (fig. 3), at the eastern edge of the land owned by the Station, rises to a maximum elevation of 222.2 feet above sea level and marks the southern end of the Highlands Ridge of Central Florida. South of Red Hill the land is lower, with a rather abrupt change from the "Scrub Forests" (which Davis, 1943, fig. 71, includes in the southern end of the Highlands Ridge in his map of the vegetation of southern Florida) to the Pine Flatwood Forests, Wet Prairies, and Inland Swamps of the ill-defined region known as the Everglades. West of the Archbold

Biological Station most of the timber has been cut from the Pine Flatwoods, although a few small hammocks remain. Two small pools, one of them partially excavated, are on the property of the Biological Station.

Climatic records for Highlands County over a period of 37 years have been taken at Avon Park, which lies roughly 25 miles in air-line distance north of Lake Placid. As reported by the United States Department of Agriculture (1941), the mean annual precipitation is 52.12 inches. The maximum (air) temperature is 102° F. (40° C.) and the minimum 21° F. (-5.5° C.)

APPARATUS AND METHODS

Owing to wartime scarcities of materials our apparatus was in part improvised with the equipment available at the Archbold Biological Station. A chamber in which temperatures could be controlled and maintained at suitable levels was prepared by

Mr. Richard Archbold who conceived the ingenious notion of converting a well-insulated butcher's display case (fig. 4) that he had on hand. The case, except the doors, on the upper portion was constructed of sheet iron glazed with white enamel, with

the inner wall insulated from the outer wall. Sliding doors on the upper portion were made of wood, with inner and outer panes of glass holding an insulating layer of air in between. Hinged insulated doors on the lower portion opened on the floor of the case. Inside, the chamber was divided into an upper and a lower compartment by a shelf comprised of metal grills permitting free circulation of the air. Boards were placed on this shelf in such a manner that only the ends of the shelf were open.

wet-bulb temperatures, while the other recorded air temperatures.

After the thermostat was set to maintain the temperature at $38^{\circ}\text{C}.$, the chamber was operated for several hours before any animals were placed in it. When it was ready for use the temperature was found to be maintained satisfactorily. The air temperatures in the chamber varied only within the limits of $0.2^{\circ}\text{C}.$ above or below $38^{\circ}\text{C}.$ as indicated by the Bristol Recorder. As an additional precaution temperatures were

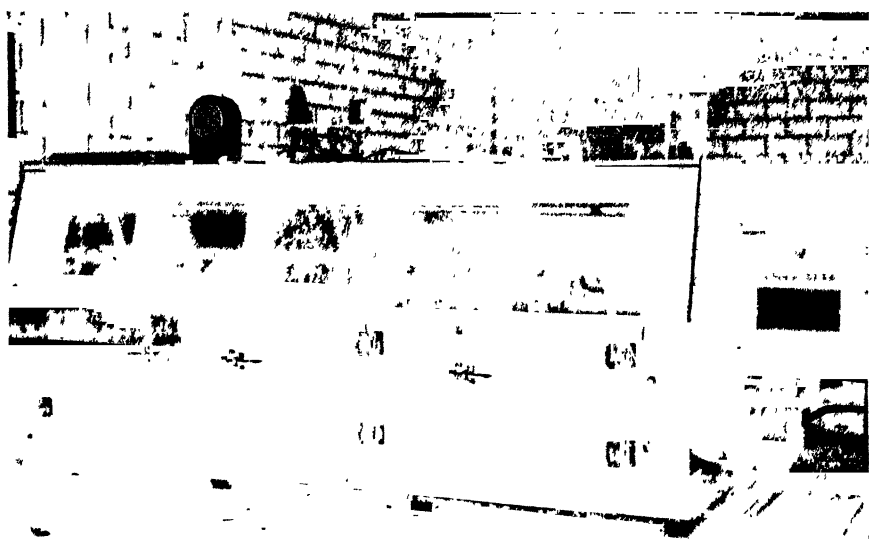


Fig. 4. The thermal chamber used in experiments, converted from a butcher's display cabinet. The apparatus at the right is a Bristol Recorder, which automatically recorded the temperatures within the chamber at two-minute intervals. The chamber was heated by means of a thermostatically controlled electrical heating element located at one end of the lower compartment, with an electric fan behind it. Temperatures of $38^{\circ}\text{C}.$ were maintained in the chamber, with fluctuations no greater than $\pm 0.2^{\circ}\text{C}.$, and with the relative humidity at approximately 37 per cent.

An electrical heating element, thermostatically controlled, was installed in the lower compartment at one end, with an electric fan behind it. The fan, maintained at a slow speed, kept the air in circulation in both compartments, although in the upper portion the movement of the air was scarcely noticeable. A Bristol Recorder was used to ascertain fluctuations in the air temperature at two-minute intervals; one terminal was inserted in a wick to record

checked frequently with thermometers calibrated by the Bureau of Standards. A closed can containing wet sand with a hole in the lid for a thermometer was placed in the upper portion of the chamber, to provide a further check. Readings from this thermometer indicated that the temperature of the sand was virtually constant at $38^{\circ}\text{C}.$

No attempt was made to vary the humidity during the series of experiments ex-

cept once when comparisons were made of moisture loss in an alligator, and the relative humidity was raised to 46 per cent for one experiment. The relative humidity was measured by comparisons of the readings on the wet and dry terminals of the Bristol Recorder and checked with a sling psychrometer suspended in front of the fan, which was momentarily accelerated. There was very little fluctuation in the relative humidity within the chamber; it remained almost constantly at 37 per cent, with fluctuations no greater than 5 per cent, except when it was purposely increased.

A series of four wire mesh cages of suitable capacity were placed in the upper portion of the thermal chamber. After these had been in the chamber for several hours, the various reptiles used in experiments were first weighed and then placed in one of the cages. Closed cans containing wet sand were also used in some experiments in order to find out whether any loss of weight occurred when amphibians or reptiles were maintained in saturated air at 38° C.

All body temperatures were taken with gas-filled mercury thermometers made for the purpose. These instruments were designed to record temperatures within the range of 0° to 50° C. and calibrated in divisions of 0.2° C. The bulb is 2 mm. in diameter and 12.0 mm. in length so that it could easily be thrust into the cloaca of even the smallest lizards. Such thermometers reach equilibrium within 15 seconds. Temperatures of all reptiles were taken before they were removed from the chamber to be weighed.

Weights, usually determined immediately after the cloacal temperature had been recorded, were taken at intervals with a balance that was accurate to 0.1 gram. Such accuracy seemed to be adequate for our purposes, although for very small specimens a more precise instrument would be desirable. Because reptiles maintained at 38° C. in a can of wet sand, in which the air was presumably near 100 per cent in relative humidity, lost no weight it seems reasonably certain that the weight lost by reptiles in the wire mesh cages represents moisture lost by evaporation.

It may be added that Benedict (1932) found no differences between temperatures taken in the mouth of snakes and those taken in the cloaca. Skin temperatures were found by him to be somewhat lower except under unusual conditions, a fact which may possibly be attributed to the loss of moisture through the skin. Benedict also found that there was a very slight rise in a snake's temperature following ingestion of food as a result of the digestive processes. Virtually all workers who have dealt with snakes under conditions where the temperature of the environment could be spoken of with accuracy have found the body temperature slightly below that of the environment. However, a moderate amount of agitation will, according to Benedict, cause a rise in the cloacal temperature of as much as 3° C. in 19 minutes.

It is pertinent, therefore, to note that none of the specimens in the thermal chamber demonstrated any inclination to be active. All of them became almost completely quiescent within a relatively short time after being placed in the cages. Many of them voided feces or water when handled the first time they were removed to be weighed, but they rarely did so on subsequent occasions. All specimens used were freshly caught. None of the snakes showed any evidence of having eaten immediately prior to capture, although it is probable that all the lizards and some of the turtles had recently eaten.

It would have been desirable to measure the loss in weight of the reptiles studied at various temperatures and humidities, since it is known that some amphibians can survive twice as much loss if evaporation is slow then they can if it is rapid. Benedict states that there is some evidence that there may be a critical temperature for water elimination between the temperatures of 30° C. and 36° C. However, with the time at our disposal it was not feasible to determine the importance of these considerations. It was necessary to restrict the present effort to experiments permitting comparison of moisture losses with all experimental animals maintained under similar conditions of temperature and humidity.

In the following account brief notes on

the habits and habitat of each species are provided in order that some notion may be had of their ecological requirements. The

species studied will be discussed in the order of their phylogenetic relationships as currently accepted.

EXPERIMENTS

The animals used in the experiments described herein have been grouped by orders and suborders to permit comparisons of the most closely related species. It should be noted, however, that because the weight of the animal, as well as the rate of water loss, varies extensively from species to species, the graphs showing actual losses in weight are constructed on different scales. An animal weighing over 2000 grams manifestly is able to lose more water than one weighing 5 or 6 grams. Water loss is possibly dependent upon several factors, not only the actual percentage of water in the tissues, but the nature and the extent of the surfaces, that is, of the lungs, skin, or intestine, through which it is lost. It is doubtful whether any entirely satisfactory means of comparing species can be devised, but rough comparisons can be made in terms of the ratio of the weight lost per hour to the original weight (see fig. 23). Whenever possible more than one specimen was used, but the results obtained with different individuals, or with repeated trials using the same individual, are sufficiently similar to show that variation is not great within the local population from which specimens were drawn.

TURTLES

On the basis of fossil evidence the turtles are the oldest surviving group of reptiles. Modern turtles are not vastly different from their earliest ancestors, reptiles that probably descended from generalized anapsids, and became incased in their bony shells by the Triassic, at least 175 million years ago. Most species are aquatic or semi-aquatic, although a few are strictly terrestrial. In general there are more species in humid than in arid regions, and relatively few of them range north of latitude 50° N. in the Northern Hemisphere.

Kinosternon subrubrum steindachneri Siebenrock

This peninsular race of the common mud turtle of eastern United States is found from central Florida northward to the upper end of the state, where it presumably intergrades with the typical race. The species, represented by the Gulf Coast race, *hippocrepis*, is found as far west as Dallas, Texas, but is replaced in the arid regions to the west by two other species. The genus is well represented in Mexico, and additional species occur in Central and South America. All of them are aquatic, although some forms live in pools or streams in desert regions, from the Colorado River eastward.

Kinosternon subrubrum steindachneri lives in streams, pools, marshes, and the smaller lakes of Florida. Carr (1940) described the species as "very aquatic; rarely seen on land." The specimens used were ploughed from the mud surrounding a small pond at the Archbold Biological Station. Three individuals weighing, respectively, 64.7, 90.0, and 117.0 grams, were used.

The two larger turtles were kept in the thermal chamber for periods of 37 and 51 hours, respectively, and showed no ill effects from this prolonged exposure to air at 38° C.; they lived for three months afterward before they were killed and preserved. When placed in the thermal chamber both turtles had cloacal temperatures of 26° C., approximately that of the laboratory sink in which they had been kept. Within the first hour the temperature of the turtles rose to 36.5°. Although the temperature of the air within the chamber was virtually constant at 38.0° C., that of the turtles was consistently lower, varying from 34.2° to 37° C., with a mean of 36.6° C.

As indicated in figure 5, there was a steady decrease in weight, with relatively slight fluctuations. The turtles at first remained with their heads protruding and the

legs loosely extended, but after 12 hours the eyes were closed, and the neck and legs were withdrawn into the shell. The larger of the two turtles lost 23.6 per cent of its original weight in 51 hours, but in terms of the percentage of its original weight the rate of moisture loss was 0.46 per hour, or somewhat less than that for the smaller indi-

in water five minutes after it was removed. When weighed five minutes later it had increased in weight to 76 grams, doubtless from simple ingestion of water. Fifteen minutes later it weighed 79.2 grams, and a half hour later it had further increased to 81.5 grams. The following morning, nine hours after removal from the thermal cham-

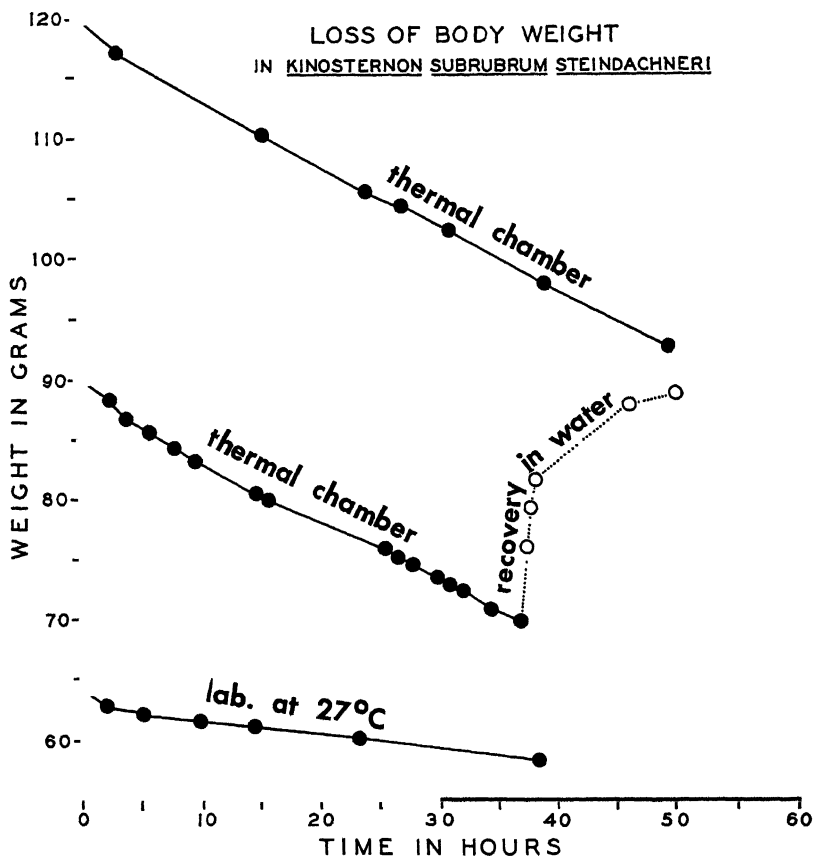


Fig. 5. The upper curves indicate fluctuations in the weight of the peninsular mud turtle, *Kinosternon subrubrum steindachneri*, in the thermal chamber (and on one, after removal). The lower curve indicates the loss in weight of a smaller turtle without access to water, in the laboratory at room temperature.

vidual, which lost moisture at the rate of 0.61 per cent of its initial weight per hour. This smaller turtle, weighing 90 grams when placed in the chamber, lost 20 grams, or 22.2 per cent of its original weight, in 37 hours.

The smaller turtle, weighing 70 grams at the conclusion of the experiment, was placed

ber, the turtle weighed 87.8 grams, and two hours later it had reached 88.8 grams, or very nearly its original weight.

A somewhat smaller turtle, weighing 64.7 grams, was placed in wet sand in a closed container in the thermal chamber. For a period of 48 hours it remained there, invariably buried in the sand except for

occasional short interruptions when it had to be removed in order to record the cloacal temperature. Although it remained at essentially the temperature of the thermal chamber, 37.9° to 38.0° C, for the 48-hour period, no weight was lost, and the turtle was in excellent condition when it was removed.

The same turtle was confined in the laboratory in a wire mesh cage without water for 37.5 hours subsequently and

tion of the United States. The subspecies (fig. 6) known as the "Florida cooter" is confined to the peninsula. The genus, however, is widespread in North America, ranging from Massachusetts southward through Mexico along both coasts to Panama. It is absent from the United States west of the continental divide, although one species occurs in southern Baja California as well as in the Rio Fuerte drainage of southern Sonora. Carr (1940,

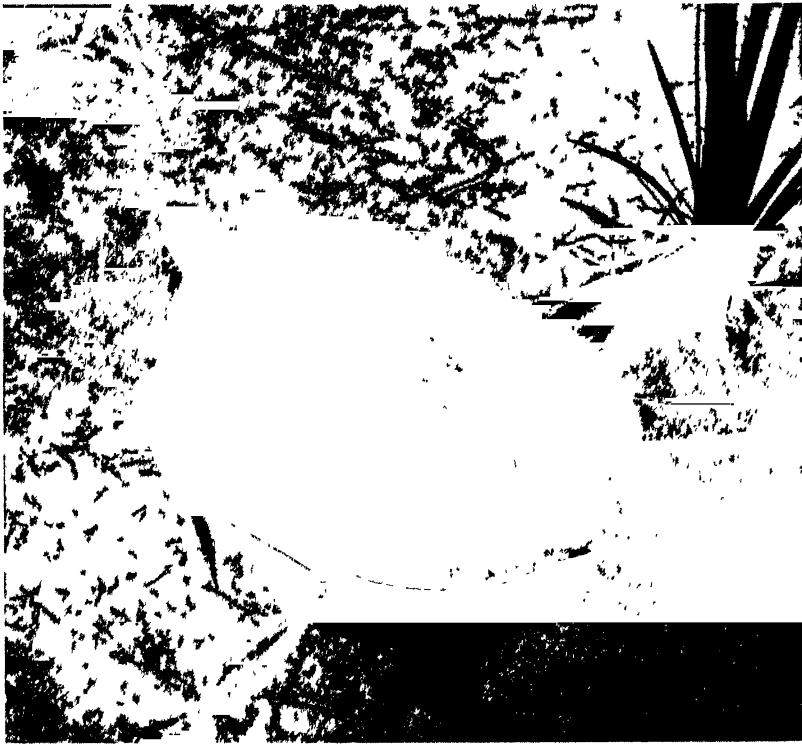


Fig. 6 The Florida "cooter," *Pseudemys floridana peninsularis*, used in experiments, an adult male weighing 2951 grams when placed in the thermal chamber.

weighed at periodic intervals. In the laboratory the turtle's temperature was almost constantly 27° C, and whereas the humidity was probably not constant, the turtle lost weight steadily but at the relatively slow rate of 4.7 grams (6.2 per cent of the initial weight) in 38.5 hours (fig. 5).

***Pseudemys floridana peninsularis* Carr**

This species is one of the common turtles throughout most of the southeastern por-

p. 103) reports that in Florida it is found in almost any aquatic situation, but it is commonest in lakes, sloughs, and the rivers of the St. John drainage. Furthermore, he notes that turtles of both sexes wander on land on warm winter days and in early spring. The specimen used was taken at the edge of the Archbold Biological Station in a relatively dry, sandy area where its wanderings had been impeded by a fence.

When placed in the thermal chamber the

turtle had an initial body weight of 2951 grams, and the body temperature was 25.5° C. Fifty minutes later the cloacal temperature had risen but 1.5°, and no loss in weight was detected. Three and a half hours after it had been placed in the chamber its temperature reached 34.5° C., and at the end of a five and a half hour period the temperature was 36.0° C., although there had been a sudden drop in weight, doubt-

later the "cooter" had exceeded its original weight by 115 grams. Evidently, therefore, the moisture reserve of the turtle had been somewhat depleted at the time it was captured, presumably because it may have come some distance over dry land. Nevertheless it still had sufficient water in reserve to maintain itself for at least 49 hours under the extreme conditions of the thermal chamber despite the fact that it lost 14.4

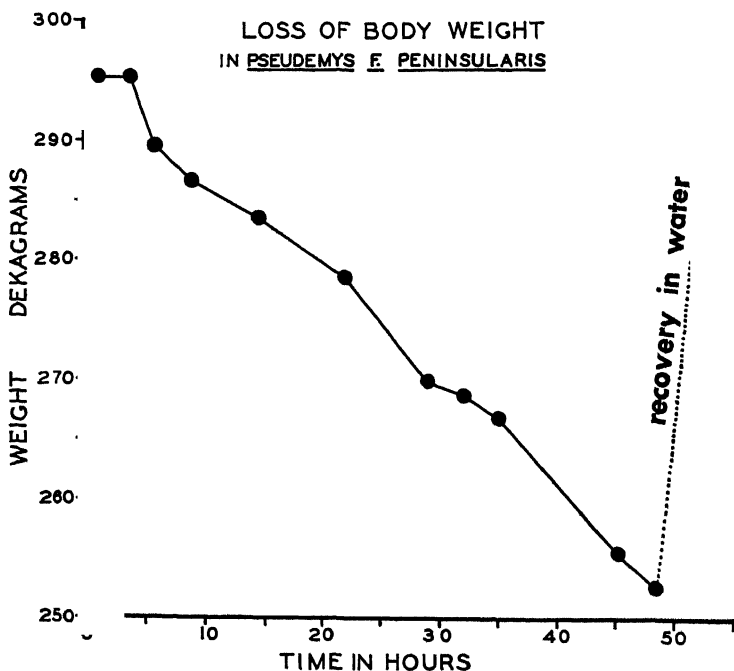


Fig. 7. Weight lost by the turtle, *Pseudemys floridana peninsularis*, during 49 hours in the thermal chamber. Dotted line indicates the recovery of water in sufficient quantity to raise its weight to a figure exceeding its original weight, after being placed in water at room temperature (usually near 27° C.) for four hours.

less attributable to water voided from the bladder. The initial rapid loss (fig. 7) was followed by a generally steady but somewhat erratic reduction in weight. The body temperature was maintained between the limits of 35.0° and 36.9° C., with 36.0° as the mode. The turtle was removed at the conclusion of 49 hours in the thermal chamber, after having lost 425 grams, and placed in water. When weighed again four hours

per cent (425 grams) of the initial weight. This chelonian was losing moisture at the rate of only 0.29 per cent of its initial weight per hour, even though its reserve was presumably below normal at the time the experiment was begun. Obviously the "cooter" can remain out of the water at relatively high temperatures for prolonged periods with little risk of severe desiccation.

***Terrapene carolina bauri* Taylor**

The Florida box turtle (fig. 8) is widely distributed on the peninsula, and according to Carr (1940, p. 100) it inhabits principally flatwoods, upland and mesophytic hammock, but occurs in high pine forests. It was of uncommon occurrence at the Archbold Biological Station where only a single individual was taken during two months' work. Box turtles of the genus *Terrapene* are largely terrestrial, but occasionally they enter the water. They occur throughout

spread but individuals attained greater dimensions during the Pleistocene. *T. ornata* is the only species inhabiting moderately arid terrain.

The specimen used in the desiccation experiment was an adult female weighing 293.5 grams when placed in the thermal chamber. The shell could be closed so tightly with the close-fitting plastron that it was impossible to secure temperatures without damaging the turtle. Consequently no data could be recorded except



Fig. 8. The Florida box turtle, *Terrapene carolina bauri*, used in experiments, an adult female weighing 293.5 grams when first placed in the experimental chamber.

most of the United States east of the Rocky Mountains, and one species, *T. ornata*, has a range extending from the Great Plains across the continental divide into southeastern Arizona. The range of the genus extends southward to Yucatan along the east coast of Mexico, and two species occur in Sonora and Nayarit, respectively, on the Pacific slope; an additional form is known only from northern Coahuila. The genus evidently was not only much more wide-

the reductions in weight at periodic intervals. Moisture was not lost at a steady rate (see fig. 9), even though conditions of humidity and temperature were essentially constant in the chamber. During a 45-hour period this box turtle lost 50.8 grams, or 17.3 per cent of its original weight. The mean rate of moisture loss for the full period was 0.38 per cent of the body weight per hour, or essentially the same as that for

another terrestrial species, *Gopherus polyphemus*.

Gopherus polyphemus (Daudin)

The gopher tortoise (fig. 10) inhabits upland sandy areas throughout most of Florida, as well as the Gulf Coast. Its nearest relatives are (1) *G. berlandieri*, the species that inhabits central Texas southward into Nuevo Leon, Mexico, east of the Sierra Madre Oriental, and (2) *G. agassizii*, an inhabitant of the arid Southwest, with a

shun water, aside from the moisture of the burrow. The temperatures of gopher tortoises taken immediately after capture ranged from 34° to 35° C. The individual used in the experiment was a small one, 10 cm. long or scarcely one-third the length of a full-grown specimen and considerably lighter in weight.

When placed in the thermal chamber this juvenile tortoise weighed 208.2 grams, and since it had been sunning itself in an outdoor cage the cloacal temperature was

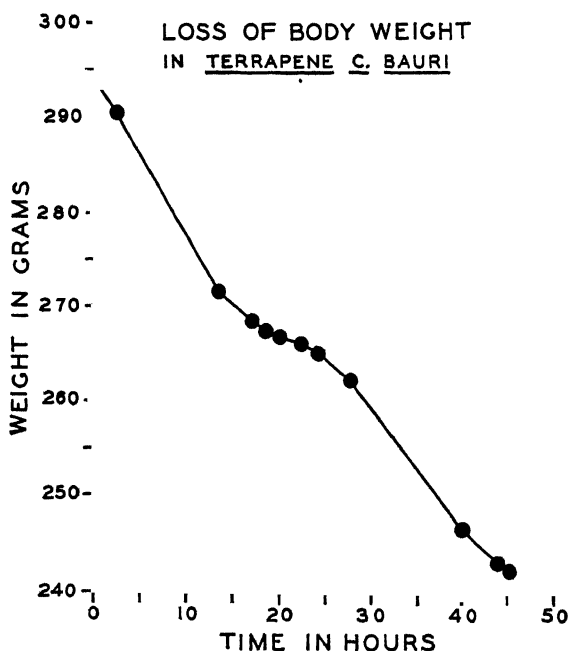


Fig. 9. Graph showing the loss of weight in an adult box turtle under experimental conditions of constant temperature and relative humidity.

range encompassing most of the Colorado and Mojave deserts, from Sonora northward to southwestern Utah. *Gopherus* is closely related and essentially congeneric with *Testudo*, a genus with species in the temperate and tropical regions in many parts of the world.

In Florida the gopher tortoise inhabits pine forests or cleared areas, where it commonly constructs burrows 30 feet or more in length. Such terrestrial chelonians are not adapted for swimming and normally

36° C. at the beginning of its confinement. Part of the abrupt loss in weight (see fig. 11) during the first three hours resulted from the liquid expelled through the cloaca when the animal was overturned to permit insertion of the thermometer into the cloaca. Nevertheless moisture was lost at a rapid rate during the ensuing period until the twentieth hour of confinement when it abruptly began to diminish. After 40 hours in the chamber the head and feet were constantly withdrawn and the eyes were closed.

Relatively little moisture was being lost after the seventieth hour, but after the seventy-fifth hour there was a marked increase before death followed 4.25 hours later.

Throughout the experiment the cloacal temperature of the tortoise, which fluctuated between 37° and 38° C., was very nearly that of the surrounding air. The difference between the means for the air and for the turtle are but 0.54° C., so that despite the loss of 63.2 grams, or 30.4 per

agassizii) increased in weight 41 to 43 per cent. If the weight lost by the gopher tortoise is calculated in terms of the percentage of the weight at the conclusion of 79.25 hours in the thermal chamber, the proportionate amount of water lost (43 per cent) is virtually the same as that ingested by the desert tortoise. It seems improbable, however, that the desert tortoise had no water in reserve at the time it was capable of drinking an amount equal to 43 per cent of its body weight, whereas the reserve in the

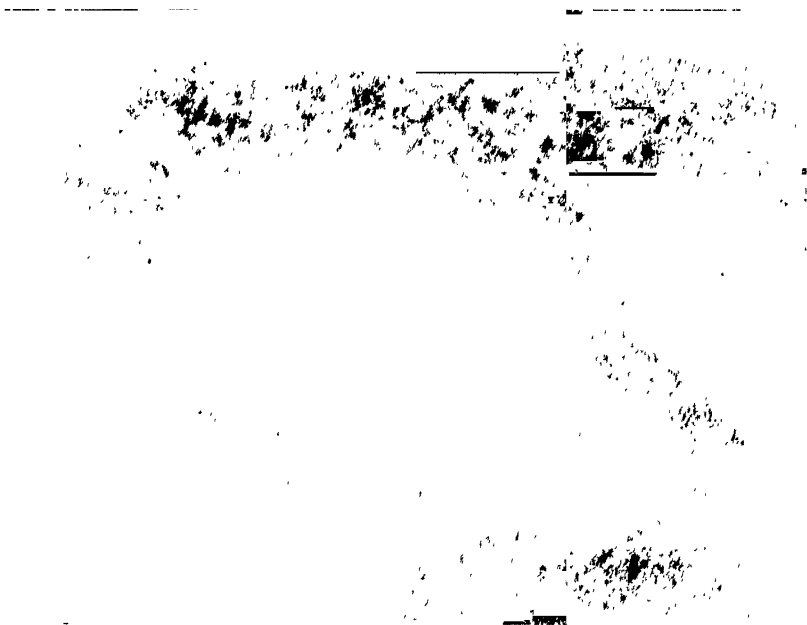


Fig. 10. The gopher tortoise, *Gopherus polyphemus*, a terrestrial chelonian of the species used in experiments. The photograph depicts an adult female, whereas a juvenile weighing 208.2 grams was used.

cent of the original weight, very little lowering of the body temperature resulted. Moisture was lost at a mean rate of 0.42 per cent of the initial weight per hour for the full period of 79.25 hours.

It is probable, but uncertain, that the tortoise died as the result of desiccation rather than from the long exposure to an environmental temperature of 38° C. It is of interest to note in this connection that Miller (1932, p. 196) reports that, after drinking, the desert tortoise (*Gopherus*

gopher tortoise was presumably exhausted at the time the reptile died. The desert tortoise must rely upon infrequent rains before it can drink, and most of the water utilized is supposedly derived from plant material consumed. On the other hand, summer rains are frequent in the region inhabited by the gopher tortoise, and there is less need for conservation of moisture. Whether the desert tortoise can store more water than its peninsular relative remains to be determined experimentally.

CROCODILIANS

The crocodilians, descendants of Triassic thecodont reptiles that also gave rise to the dinosaurs, are represented by 25 surviving species. All of them are essentially aquatic, inhabiting rivers, lakes, and estuaries, or even the oceans to a limited extent. For the most part they are confined to the tropics and subtropics, living in environments that presumably approximate those

The American alligator is primarily an inhabitant of swamp-bordered streams, although it is found in virtually any aquatic situation, including brackish and even salt water. It ranges from the swamps of the Carolinas southward throughout Florida and westward along the Gulf Coast to the Rio Grande in Texas. At the Archbold Biological Station small alligators were seen in drainage ditches, roadside pools, and in

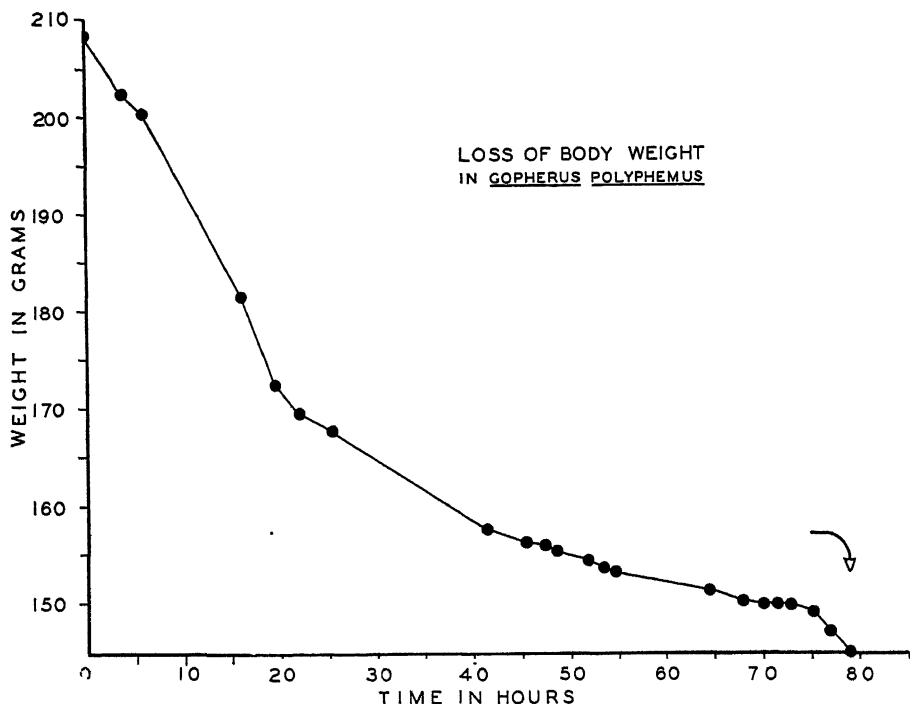


Fig. 11. Loss of weight in *Gopherus polyphemus* during 79.25 hours in the thermal chamber. Death ensued after 30.4 per cent of its initial weight had been lost.

that were more widespread during the Mesozoic era. An alligator as well as a crocodile (*Crocodylus acutus*) occurs in Florida. The American alligator (*Alligator mississippiensis*), however, is more widespread and abundant in Florida. The closest living relative of the latter is the Chinese alligator (*A. sinensis*), with a restricted range in the vicinity of Shanghai, but the caimans of Central and South America are placed in the same family.

small lakes, while large individuals inhabited Lake Childs, a few miles to the north.

Additional experiments of an allied nature were carried on with alligators, and these have been reported in a previous paper (Colbert, Cowles, and Bogert, 1946). For the purposes of this report only the data concerning moisture loss are presented, with additional notes not included in the previous work.

Alligator mississippiensis (Daudin)

The alligator (fig. 12) used in these studies was a juvenile, 630 mm. in total length, that had been taken in a local drainage ditch a few days prior to its use. It was kept in the thermal chamber for two periods, first with the relative humidity in the chamber at 27 per cent, and three months later, in a second trial of shorter duration, with the relative humidity maintained at approximately 46 per cent. The temperature of the air in the chamber was the same in both instances.

the chamber and placed in water, the animal ingested water immediately. Within half an hour it had taken in 28.7 grams of water, and after spending the night in a wet sink with a pan of water the weight had increased, at a somewhat slower rate, to 629.6 grams, within 40 grams of the initial weight. Three months later, when the second trial was begun, the weight had increased to 654.5 grams.

During the period that the alligator was in the chamber it remained quiescent with the mouth slightly open. Apparatus was



Fig. 12. American alligator, *Alligator mississippiensis*, juvenile individual used in experiments.

In the first trial the alligator weighed 668.1 grams at the beginning, but lost weight rather rapidly. The initial loss can be attributed to liquid expelled through the cloaca, but after five hours moisture was lost at a constant rate approximating 5.5 grams per hour (see fig. 13). In terms of the initial body weight the loss amounted to 0.83 per cent per hour for the 24-hour period. At the conclusion of the experiment this crocodilian had lost 133.5 grams, or 19.3 per cent of its original weight, and death undoubtedly would have resulted had the experiment been continued for many hours more. However, when removed from

not available to determine the respiration rate with accuracy, although it had undoubtedly increased. The body temperature fluctuated between 35.5° and 38.0° C., but remained above 37.0° after the first hour. The mean temperature for the period, exclusive of the first 15 minutes, was 37.0° C.

In the second experiment, with the relative humidity in the chamber at 46 per cent, the initial loss was not so rapid as it had been in the previous experiment, although the curve for the loss of weight (fig. 13) was similar in some respects to that for the first trial. With the increased humidity of the

chamber during the second trial, however, moisture was lost somewhat less rapidly, at a mean rate of 0.52 per cent of the initial weight per hour for the 12-hour period. At the conclusion of the experiment, the alligator was removed from the chamber and placed in water, where it regained 33.2

moisture recovery is dependent upon the amount of desiccation.

Although in the second trial moisture evidently was lost at a somewhat slower rate, presumably because of the increased humidity in the chamber, the effect on the alligator's body temperature was relatively

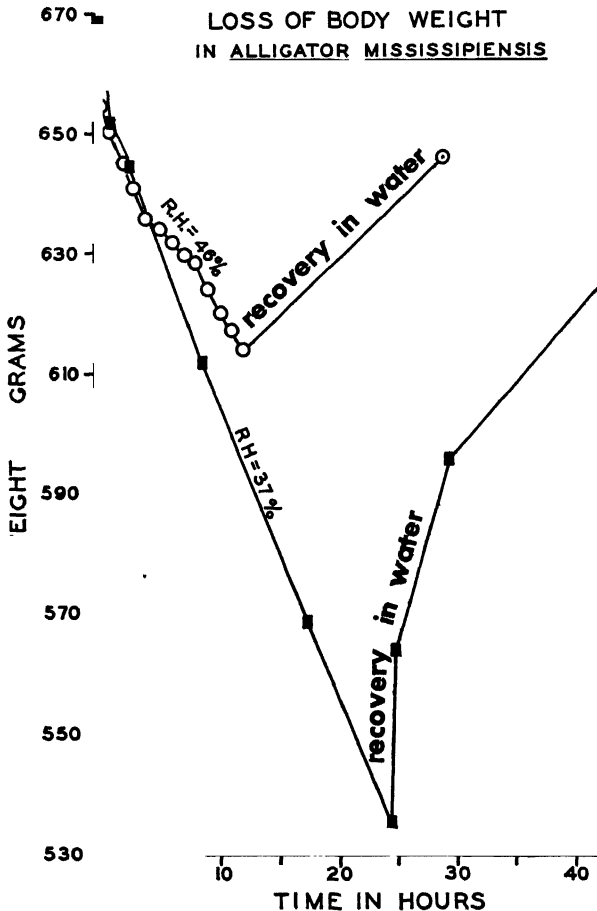


Fig. 13. Weight lost by a small alligator during 24 hours in the experimental chamber. The line at the right indicates the rate of recovery when the animal was placed in water.

grams during a period of 14.75 hours. It is of interest to note that the rate of recovery in water following the second trial, when the alligator was reduced in weight to only 613.2 grams, closely parallels that for the final stage of the recovery following the first trial. Evidently, therefore, the rate of

small. The mean temperature for the 12-hour period was 37.6° C., or 0.6° C. above the mean for the same alligator kept in the chamber when the relative humidity was 27 per cent. It may be observed that a body temperature slightly exceeding 38° C. represents the lethal for the American

alligator, so that in this instance the dissipation of body heat that accompanied the loss of moisture probably saved the animal from death. Under exceptional conditions in a natural state this margin of safety would have considerable survival value.

LIZARDS

The oldest fossils referred with certainty to the Suborder Sauria (lizards) are from the Jurassic, and most of the existing families are unknown from strata older than Cretaceous. As a group, lizards did not flourish until Tertiary times, when they began to occupy the varied habitats in which they are found today. The larger forms are confined to tropical and subtropical climates and relatively few species, most of them small, are found north of latitude 50° N. Lizards are absent from the summits of the higher mountains, except in the tropics, and whereas they occur in exceedingly moist climates they tend to be more abundant in arid or semi-arid regions.

The majority of the families include nocturnal or secretive forms, although others, notably the Iguanidae and Agamidae, are composed almost wholly of diurnal species. Arboreal, cursorial, as well as subterrestrial lizards have evolved in several family groups, and species representing intermediate states of specialization exist in many instances. All amphisbaenids are burrowing creatures, most of them limbless and with vestigial eyes. But among the Scincidae various species represent virtually every degree of specialization for a burrowing existence.

The terrestrial species, of course, were those most commonly seen at the Archbold Biological Station, but subterrestrial as well as arboreal lizards were occasionally taken.

Sceloporus woodi Stejneger

The scrub pine lizard is one of the few iguanids inhabiting Florida. The genus *Sceloporus* is more typically an inhabitant of semi-arid regions, although it enjoys a wider distribution than any North American iguanid. The *undulatus* group of the genus, to which *woodi* belongs, occupies most of the United States, although it is ab-

sent from the most arid portions of the country. *Sceloporus woodi* is an abundant cursorial species, with a range limited to the drier rosemary scrub in central and southern Florida. At the Archbold Station it was particularly common at Red Hill, nearly always on the ground at the edge of trails or cleared areas. When frightened it occasionally climbed a tree or a post, but more often it fled across the sand.

An adult male with a cloacal temperature of 36.6° C. at the time of capture had a body weight of 6.0 grams when placed in the thermal chamber. Although the cloacal temperature had risen to 37.4° C. when the animal was weighed 2.5 hours later, there

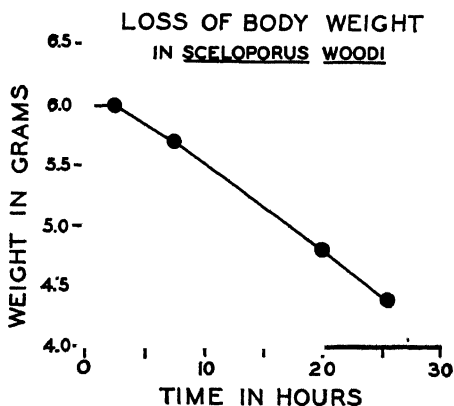


Fig. 14. Graph showing the water loss in the scrub pine lizard, *Sceloporus woodi*.

was not enough loss in weight to register on the balances used. At the time of the second weighing, 7.5 hours after the start of the experiment, the lizard had lost 0.3 grams in weight, and the body temperature had risen to 37.5° C. and remained near that figure for the duration of the experiment. Although the lizard was weighed only twice during the ensuing time that it was kept in the thermal chamber, the rate of moisture loss was apparently nearly constant at approximately 0.064 grams (or 1.06 per cent of the initial body weight) per hour. At the conclusion of 25.25 hours the lizard had lost 1.6 grams, or 26.7 per cent of its original weight. When liberated outside the laboratory, it immediately climbed the stucco wall. However, it was relatively

slow in its movements and not nearly so agile as a lizard of the species that had been kept in the laboratory at room temperature for a similar period.

A smaller male weighing only 3.8 grams was placed in the thermal chamber under the same conditions, but it was removed after nine hours and ten minutes with the hind legs paralyzed, supposedly as the result of heat trauma. It died the following day. During the time it was in the thermal chamber it lost 0.4 gram in weight, or 10.53 per cent of the original weight, at a mean rate of approximately 1.14 per cent of its original weight per hour. The rate of

39° C. for short periods of time, and when heated rapidly death does not ensue until a cloacal temperature slightly exceeding 44° C. is reached. Nevertheless, prolonged exposure to body temperatures nearly 2° C. above the mean for the normal activity range may be sufficiently deleterious to cause death.

Eumeces inexpectatus Taylor

The Scincidae are virtually cosmopolitan in distribution, but far more abundant in the Old World, particularly in the Australian region, than they are in the Americas. Most skinks are terrestrial and



Fig. 15. The Gulf Coast skink, *Eumeces inexpectatus*, used in experiments.

moisture loss compares favorably with that recorded for the male weighing 6 grams.

To ascertain the effects of the same amount of heat with the humidity at a higher level, a female weighing 5.0 grams was kept in the thermal chamber. It remained inactive but could move rapidly when stimulated. Nevertheless it was dead 12 hours afterward, possibly from the effects of the temperature at which it had been maintained. *Sceloporus woodi* has been taken in the field with cloacal temperatures varying from 32.0° to 39.0° C. (the normal activity range), but the mean for 42 specimens is $36.2 \pm 0.79^\circ$ C. Undoubtedly the lizard can tolerate temperatures of

secretive in habits, although many of them are burrowers. In general they are restricted to moist situations, and in the Americas they are absent from the deserts. Skinks are more abundant in eastern United States where the mean annual rainfall in most areas exceeds that for most of the region west of the Rocky Mountains. More than twice as many species of the family Scincidae are found east of the continental divide than occur in the territory to the west. In fact seven scincids occur in Florida, in contrast to six found in the entire Pacific drainage of the United States.

The common skink at the Archbold Biological Station was *Eumeces inexpectatus*.

tus, although it was neither abundant nor easily caught. Most individuals taken were found under boards, logs, or debris where there was plenty of moisture. These skinks were rarely seen abroad, although the largest individual obtained (weight 14.3 grams) was found while basking at periodic intervals at the entrance to a shed in a plant nursery located in Bear Hollow, a few miles southeast of the Archbold Biological Station. When captured this individual had a body temperature of 33.2° C. It was placed in the direct sunlight on a warm pavement where it reached the critical maximum (as defined by Cowles and Bogert, 1944) at 41.6° C. in five minutes, and subsequently recovered.

A skink weighing 4.5 grams was placed

however, to 38.0° C., that of the air and the container in the thermal chamber.

The curve for the loss of body weight in this specimen is peculiar, and it is unfortunate that no specimens were available to carry out additional experiments under similar conditions of temperature and humidity. Why weight was not lost during the initial 2.5 hours in the thermal chamber, but suddenly began to drop at the rapid rate of 0.5 gram per hour cannot be explained. The diminishing rate of moisture loss to a mean of 0.065 gram per hour for the next two hours can be attributed to the fact that relatively little moisture remained in the body, more especially since there was no further loss during the ensuing 3.75 hours during which the animal died.

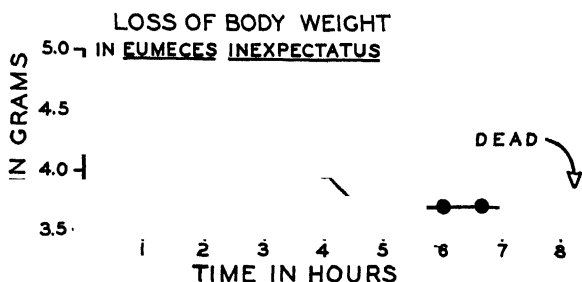


Fig. 16. Weight lost by the skink, *Eumeces*, under experimental conditions, with the environment maintained at approximately 38° C., and the relative humidity at 37 per cent.

in the thermal chamber in an open container with the initial body temperature at 34° C. Thirty minutes later its temperature had risen to 37.0° C., but no loss of weight could be detected. After an additional hour the temperature and the weight were the same. When examined following 2.5 hours in the chamber the weight still had not dropped below 4.5 grams, but at the end of 3.5 hours the weight had decreased to 4.0 grams. The lizard was still alive when examined after 5.5 hours in the chamber, with the body temperature at 37° C. and a body weight of 3.7 grams. Sometime within the next 3.75 hours the animal died, although the weight was the same as when tested at the conclusion of the 5.5-hour period. The body temperature of the dead lizard had risen,

Even though the data leave much to be desired, it is relatively certain that this skink loses moisture rapidly. For the purposes of comparison with other species, the total loss of 0.8 gram (17.5 per cent of the initial body weight) during the entire period of 8.25 hours in the thermal chamber indicates a mean loss of 2.1 per cent of the initial weight per hour under the conditions in which it was kept. Despite the fact that moisture was not lost at the beginning or at the end of the experiment, it is evident that this skink lost moisture at a more rapid rate than any reptile tested. The inability of most skinks to survive in containers when no moisture is readily available can be accounted for on this basis, and presumably the absence of skinks in truly arid environments or habitats can

be attributed to their inability to retain water under such conditions.

In a second experiment a skink weighing 8.3 grams was kept in the thermal chamber in a can of wet sand. At the conclusion of 40 minutes its temperatures had risen to 37.5° C. and the weight had increased to 8.4 grams. After 1.5 hours the weight had dropped to 8.2 grams and the temperature had subsided to 37.2° C. However, an hour later it had risen again to 37.8° C., and when the lizard died after only 5.5 hours in the thermal chamber the body was still 37.8° C. and the weight had returned to the original figure of 8.3 grams.

It is of interest to note that the larger

The fluctuations in the weight of the skink in the moist atmosphere suggest that moisture is absorbed or lost in some obscure fashion, even when the relative humidity approaches 100 per cent. The physiological aspects of the problem remain to be investigated.

Rhineura floridana (Baird)

The Florida worm lizard, as are the majority of the Amphisbaenidae, is completely fossorial. Ordinarily it is found when accidentally dug from the ground, although according to Carr (1940, p. 77) occasionally it is discovered beneath logs or leaf mold. Some of the larger South Ameri-



Fig. 17. The Florida worm lizard, *Rhineura floridana*. These lizards lose moisture rapidly when placed in dry sand, but absorb water when returned to moist sand, their normal habitat.

skink, under conditions where the humidity approached saturation, survived for a slightly shorter period than the smaller one in an atmosphere where the relative humidity was 37 per cent. Quite possibly the difference is the result of the lower body temperature that could be maintained by the lizard in the drier atmosphere. In the closed container the skink probably died from overheating, but in the open container high temperatures as well as desiccation were responsible. As noted above, this species can survive exposure to body temperatures as high as 41.6° C. for a brief interval, but body temperatures of 37° C. are undoubtedly above the normal activity range.

can amphisbaenids occasionally move about on the surface, and in Africa, at least, floods sometimes force them to abandon their subterranean habitats; if the water rises sufficiently high they drown in fair numbers. All members of the family are vermiform and, with the exception of three species (in a single genus known from western Mexico and the extreme southern portion of Baja California) that retain vestiges of the fore legs, they are limbless.

The four species in North America are clearly relicts, with ranges restricted to what Schmidt (1943) has termed "paleopeninsulae." Fossils from the Oligocene of South Dakota have been referred to *Rhineura*, although the genus is restricted

to the northern half of the peninsula of Florida at present. Representatives of the family reach their greatest abundance in Africa and South America, and most of them seem to prefer a relatively moist, tropical or semi-tropical climate. Presumably they are absent from southern Florida because of the periodical floods and the inadequate drainage that characterized the region prior to man's activities.

Carr (*supra cit.*) describes the habitat as "upland and mesophytic hammock; high pine; usually in dry soil." Contrary to Carr's impression, it seems likely that the characteristic habitat is moist soil, more often of sand where there is adequate drainage so that the surface may be dry. Land subject to periodic inundation is almost certainly an unsuitable habitat for such lizards; under laboratory conditions they do not survive in dry sand.

Only two specimens were secured at the Archbold Biological Station. Both of these were found when yams were being dug from very moist sandy soil near the summit of Red Hill. The day these were taken an adjacent plot of land was being plowed, and although a careful search of the furrows over two or three acres was made by following the plow, no *Rhineura* was discovered. The soil was slightly moist below the surface, but owing to the absence of larger plants there were no exceptionally moist pockets of earth in the plowed plot, whereas the yams in the adjacent garden apparently held more moisture in their root systems where the specimens were found. The tubers were but a few centimeters below the surface, and both lizards were dug from a depth, as nearly as could be estimated, between 10 and 15 cm. where the soil at that time of year (September 13) had a temperature approximating 32.5° C. The surface temperature slightly exceeded 60° C., and gradually diminished to 29° C. at a depth of 30 cm. Below that, at least to a depth of 70 cm., it remained virtually constant at 29.5° C., with a rise of 0.5° C. between the depths of 40 and 50 cm. Thus, by burrowing in the sand, the *Rhineura* could choose between environmental temperatures ranging from 29° to at least 50° C., although it is

probable that temperatures much exceeding 35° C. were avoided.

Equipment to determine the weight with the accuracy required was not available at the Biological Station, so the two *Rhineura* were taken alive to New York City. Here one was placed in moist sand and the other in dry sand at room temperatures. The individual in dry sand was dead within 24 hours, evidently shrunk and desiccated. The other was kept in a large glass jar where there was some opportunity to observe its movements. The jar was filled two-thirds with sand sufficiently moist that the particles tended to adhere; the upper layer was dry sand. Although the lizard occasionally burrowed in the dry sand, there was no evidence that it ever came to the surface. More often it remained at the bottom of the jar at a depth of 20 cm., making a network of burrows in the moist sand.

The lizard was kept alive for a year, during which time it was observed to be active at temperatures between 20° and 38° C. It was fed on a diet of termites, and was observed feeding at temperatures between 18° and 35° C. At higher temperatures it remained inactive at the bottom of the jar, and finally died when the temperature of the moist sand rose to 41.5° C., even though it survived at this temperature for two days.

It was not feasible to experiment with the *Rhineura* under conditions where a constant temperature could be maintained, but the animal appeared to be ideal for the purpose of ascertaining whether moisture could be absorbed through the skin. The lizard was weighed on an analytical balance sensitive to $\frac{1}{20}$ of a milligram, and found to have a weight of 3.42 grams, when placed in a jar of dry sand at a temperature of 27° C. Two hours later the lizard was removed and weighed immediately. The weight had dropped to 3.29 grams, indicating a loss of 0.13 gram for the two-hour period. Fifteen minutes after removal from the dry sand the lizard was restored to moist sand at the same temperature as the dry sand. The following day, after 24 hours in the moist sand, the weight of the *Rhineura* had increased to 3.47 grams, slightly more than when first removed from the jar of moist

sand. When the experiment was repeated on subsequent occasions very nearly the same results were obtained.

Under the same conditions of the experiment it is improbable that sufficient moisture was available in the sand to permit the lizard to ingest water by way of the mouth. Other lizards with forked tongues lap water with the tongue, but *Rhineura* appears to use the tongue solely for the purpose of picking up odorous particles to be carried to the organ of Jacobson. Following each thrust of the head, as the lizard forced its way through the soil, the head was raised and slightly withdrawn to permit the tongue to be used. Whether directed by olfactory or auditory cues, the lizard, with amazing accuracy, managed to direct itself to the clusters of termites that had tunneled into the sand from the surface. When water was poured in a burrow, however, the *Rhineura* invariably retreated, and demonstrated no desire to drink. Hence there is reason to assume that the increase in weight following desiccation in dry sand can be attributed to the absorption of moisture through the skin.

The results of this experiment are, of course, not comparable to those derived from keeping lizards in the thermal chamber at constant, higher temperatures. *Rhineura* was omitted from figure 23 for this reason. Nevertheless it is instructive to note that in dry sand at temperatures approximating 27° C. the worm lizard lost moisture at the rate of 0.065 gram per hour. The reptile was not kept in dry sand for periods exceeding two hours, but if moisture had been lost at a steady rate, the original weight would have been decreased 35 per cent within a 24-hour period. The lizard presumably would have perished as a result.

At the same time that *Rhineura* was being tested in dry sand a specimen of the California limbless lizard, *Anniella pulchra*, was made available through the kindness of Mr. Charles M. Miller. During 24 hours in dry sand the original weight of this lizard decreased but 6.5 per cent. In moist sand the weight increased from 4.415 to 4.435 grams after 24 hours. Thus moisture ap-

pears to be lost or absorbed through the skin of *Anniella*, but not so rapidly as in *Rhineura*. Presumably these differences are reflected in the nature of the habitats in which the lizards live. *Anniella* is most commonly found in relatively moist situations in a semi-arid, mesothermal climate with a summer deficiency in rainfall, whereas the range of *Rhineura* is restricted to regions having a sub-humid, mesothermal climate, with a rainfall distributed throughout the year, and a total rainfall about thrice that of coastal southern California where *Anniella* is most abundant.

SNAKES

Snakes are essentially specialized lizards that evolved from the same platynotid stock that gave rise to the modern Varanidae. It is not impossible that some of the families independently evolved from other saurian stocks. There are few fossils to trace the ancestry of the families currently included in the Suborder Serpentes, and with only recent material from which to draw conclusions the relationships of some of the groups are uncertain. Although snakes are derived from saurian ancestors, the evolution of snakes and lizards evidently was almost coetaneous, since fossil serpents begin to appear in the late Mesozoic, whereas those belonging to modern progressive stocks do not appear until the Oligocene.

Except for a few islands, snakes occur in most parts of the world where the subsoil is not permanently frozen. Evidence thus far assembled indicates that snakes, on the whole, prefer somewhat lower body temperatures than lizards. In temperate climates, as well as in the tropics, many species tend to be nocturnal or crepuscular in habits.

About 20 kinds of snakes are known to inhabit the land surrounding the Archbold Biological Station, but only a few of the diurnal species were at all abundant. The three found in sufficient quantity to permit their use in experiments all belong to the family Colubridae, and the species used are not distantly related.

***Drymarchon corais couperi* (Holbrook)**

The indigo snake inhabiting Florida is one of several races belonging to a species with a range extending from southeastern United States into South America. In the United States the indigo snake is restricted to the Atlantic Coastal Plain, from the Carolinas southward throughout Florida, and westward along the Gulf Coast to Texas. *Drymarchon* is absent from the Mexican Plateau, but its range extends along both coasts of Mexico, into Texas on the east, and into the moist barrancas of southern Sonora on the Pacific coast. It may occur in some of the barrancas north of the Rio Fuerte drainage in southern

A rather small specimen weighing 368.5 grams was placed in the thermal chamber where its initial body temperature of 26.9° C. rose to 37.5° C. within two hours, but occasionally dropped to as low as 36.0° C. before the snake was removed at the conclusion of 9.5 hours. During this period of time the snake lost weight at an exceedingly rapid, but slowly diminishing rate, losing moisture to the extent of 46.2 grams at a mean rate of nearly 5 grams (1.3 per cent of the original weight) per hour. When removed from the thermal chamber and placed in a laboratory cage, the snake was abnormally sluggish in its movements, and it died within seven hours.

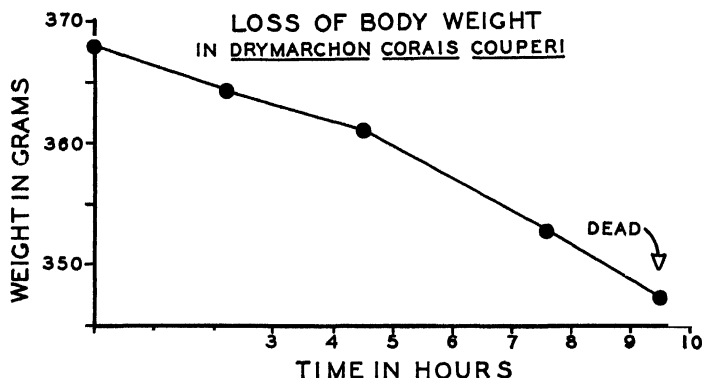


Fig. 18. Graph showing the rapid rate of moisture loss in the indigo snake, *Drymarchon corais couperi*, under experimental conditions. The snake died a few hours after its removal from the thermal chamber after 9.5 hours of exposure to virtually constant environmental temperatures of 38° C., with the relative humidity at approximately 37 per cent.

Sonora, but without doubt it is absent from the arid coasts of the state in the Colorado Desert.

In Florida *D. c. couperi* inhabits several types of terrain, but Carr (1940, p. 83) reports that it is most abundant south of Lake Okeechobee near the lower end of the peninsula, where it is often plowed from the damp soil of truck fields. The indigo snake is rarely encountered at the Archbold Biological Station, although it is not uncommon along the borders of Lake Childs a few miles to the north. It is one of the largest snakes inhabiting the United States, sometimes attaining an over-all length in excess of 7 feet.

A larger snake, weighing 1247.4 grams was placed in the thermal chamber, even, though it was obviously about to shed its skin. This specimen survived slightly more than five hours and weighed but 1036 grams when removed after death. The shorter period of survival undoubtedly resulted from the rapid loss of moisture under such circumstances, and the experiment tends to confirm the observations of Benedict (cited in the Introduction) who noted the increased rate of moisture loss prior to ecdysis. A few days before sloughing, captive snakes commonly seek water, and in a natural state they are usually found in some moist sanctum during similar periods.

Keepers in zoological gardens are well aware of the snake's requirements under such conditions, and it is a common practice to cover large pythons with moist towels at such times. Whereas keepers usually regard the process as one of "soaking the skin loose," it is obvious that snakes must resort to some means of avoiding the rapid desiccation to which they are subject during

grams, with an over-all length of 1145 mm., was placed in direct sunlight on a substratum with a temperature approximating 45° C. Within 10 minutes it became uncoordinated in its movements when its cloacal temperature reached 42.2° C. However, this individual recovered, so it is apparent that body temperatures somewhat higher than those reached in the

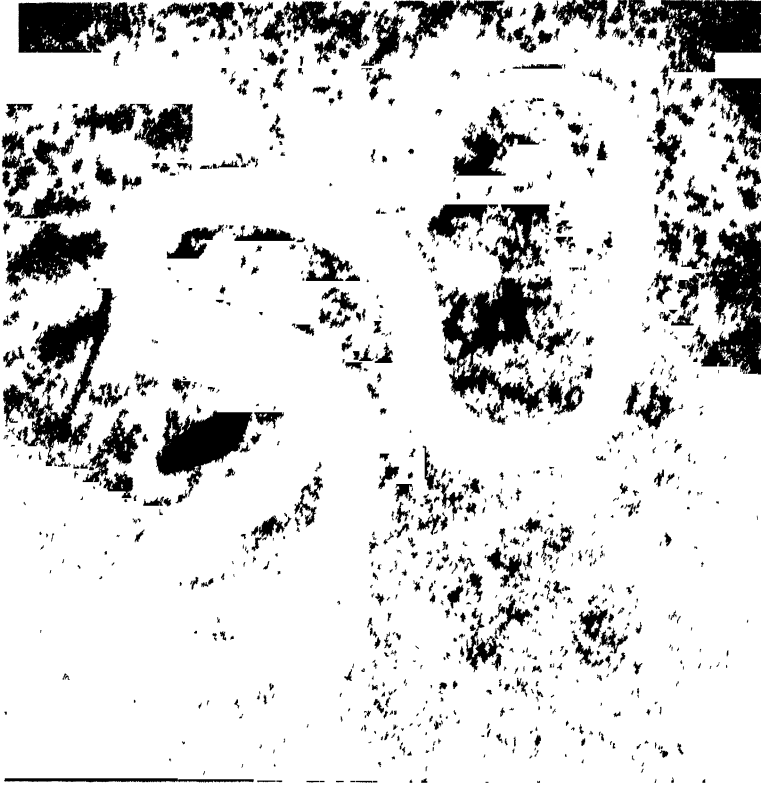


Fig. 19. The common black snake of Florida, *Coluber constrictor priapus*, one of the few reptiles that occurs in nearly every habitat in the state.

ecdysis. Manifestly a snake can prevent the loss of moisture through the skin by immersing its body, or by seeking a moist environment.

The snake in normal condition that survived for 9.5 hours in the thermal chamber presumably died as the result of desiccation, even though it lived nearly twice as long as the larger individual about to cast its epidermal covering. A snake weighing 388

grams can be withstood for periods of short duration.

Coluber constrictor priapus Dunn and Wood

The common black snake found at the Biological Station is the peninsular race of a wide-ranging species found throughout most of the United States, although it is absent from the higher mountains as well as

the deserts. In the extreme Southwest it is confined to an area on the Pacific slope where it occurs in scattered localities, principally in relatively moist valleys. An old record for the species from Fort Buchanan in a relatively arid portion of Arizona is undoubtedly erroneous despite its acceptance by Ortenberger (1928, p. 219).

The black snake was the most abundant serpent in the vicinity of the Archbold Biological Station, and specimens were seen or taken in virtually every habitat represented. Specimens used in preliminary experiments were found to be exceedingly

37.4° C. within an hour, and for the ensuing period during the experiment the recordings indicated extremes in body temperature of 37.5° to 38.0° C. The snake was found to be dead at the conclusion of 99.5 hours after having lost 57.1 grams, or 24.7 per cent of its initial body weight. As may be seen in figure 20, the weight of the snake declined at a nearly constant rate of 0.56 gram (0.25 per cent of the original body weight) per hour, and yet managed to survive for over four days.

When placed in direct sunlight on a warm day, four of these snakes reached the critical maximum at temperatures of 43,

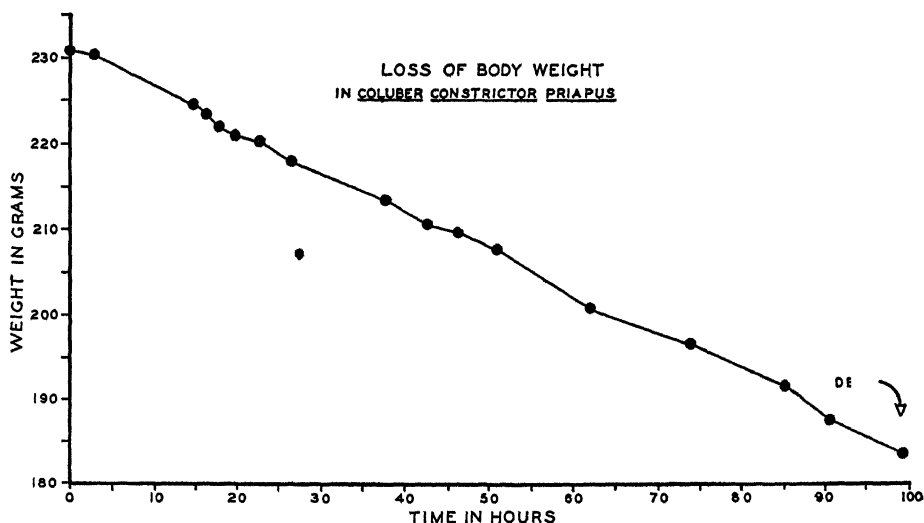


FIG. 20. Graph showing the relatively slow rate of moisture loss in the black snake, *Coluber constrictor priapus*.

hardly, unless they were approaching ecdysis. Only one healthy specimen in normal condition was kept in the thermal chamber until death ensued, although others were kept there for shorter periods. In terms of the percentage of the original weight lost per hour there was relatively little variation in several specimens tested, and for the purpose of this report the details of one experiment will suffice.

A large adult male weighing 535.9 grams was placed in the thermal chamber with an initial body temperature of 27.2° C. The temperature of the snake had reached

44, 44, and 44.5° C., respectively, and all of them subsequently recovered. Evidently, therefore, the black snake can withstand slightly higher temperatures than the indigo snake. Moreover the latter loses moisture five times as rapidly as the black snake under conditions as extreme as those maintained in the thermal chamber. The advantage this gives to the black snake is apparent from the fact that it survived 10 times as long as the indigo snake under laboratory conditions, with the relative humidity at 37 per cent, and the air as well as the cage at 38° C.

***Coluber flagellum flagellum* (Shaw)**

The coachwhip snake of Florida is a member of a species that ranges from the Atlantic to the Pacific in middle North America, occupying the valleys throughout most of the area between latitude 40° N. and the Tropic of Cancer. The eastern race, *C. f. flagellum*, is found from the Carolinas to southern Florida, and westward to the ninety-seventh meridian where

Two specimens captured at the Biological Station were available for experiments, one taken in the spring and the other near the end of the summer. Both specimens were extremely resistant to desiccation, as the following notes will indicate.

The first specimen was captured with a body temperature of 32.6° C. When placed in the thermal chamber the snake weighed 535.9 grams, and its body temperature was

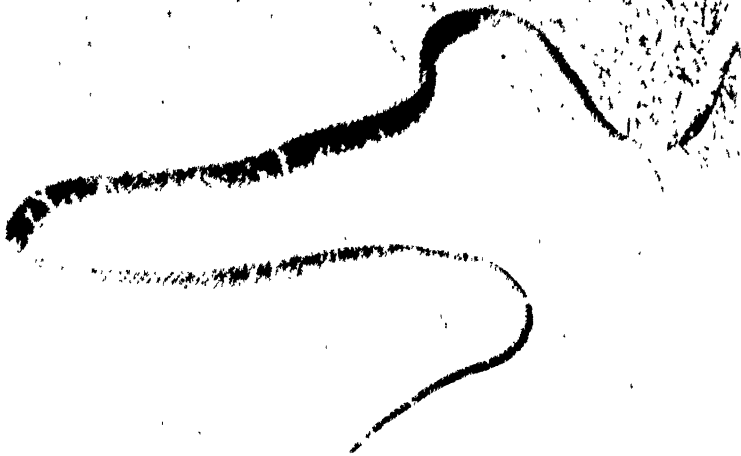


Fig. 21. The eastern coachwhip snake, *Coluber flagellum flagellum*, a snake that prefers dry habitats. This adult male was the hardiest of 10 reptiles subjected to the extreme conditions of the thermal chamber. It was alive after 99.5 hours of exposure to an environmental temperature of 33° C., with the relative humidity at 37 per cent.

it is replaced by *C. f. testaceus* in the less humid plateau region of central United States and northern Mexico. The southwestern race, *C. f. piceus*, is found in coastal as well as desert regions.

In Florida the coachwhip snake is less abundant than the black snake, and seemingly prefers somewhat more arid habitats, "high pine, rosemary scrub and dry flatwoods," according to Carr (1940, p. 81).

33.4° C. Forty-five minutes later its temperature had risen to 38° C., that of the thermal chamber. During the ensuing 46.25 hours the snake was weighed 10 times, and the cloacal temperature was obtained 12 times. Weight was lost steadily but slowly (see fig. 22) as compared with other reptiles tested, at a mean rate of 0.74 gram (only 0.14 per cent of the initial body weight) per hour.

The second specimen tested (no. 2 on fig. 22) was an adult male that weighed 655.0 grams at the beginning of the experiment. As did the previous specimen, it lost weight slowly but steadily, with a temporary decrease in the rate between the fortieth and forty-fifth hours, and a second drop in the rate after the ninetieth hour. The snake was still alive when removed at the

fluctuations in the cloacal temperature were detected. The temperature of the animal reached 38.0°C . within three hours, and remained there most of the time, rarely dropping (four occasions out of 14 that the cloacal temperature was recorded) to temperatures between 37.5° and 37.9°C .

It is significant that the relatively slow rate of desiccation was reflected in the

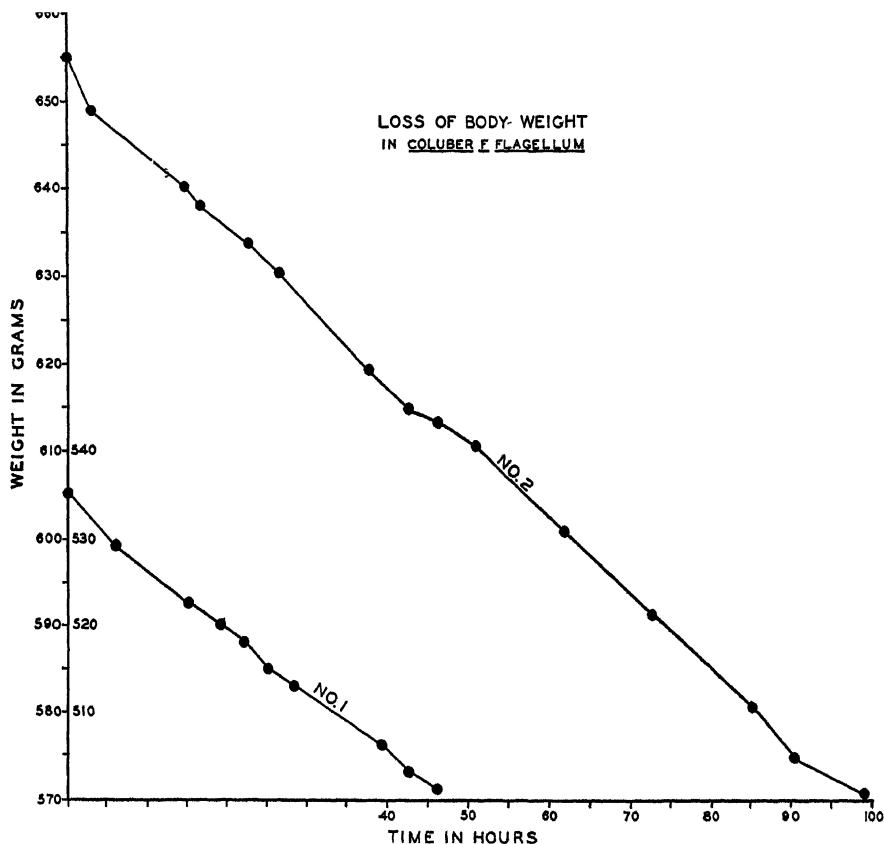


Fig. 22. Graph showing the remarkably slow loss of weight by two coachwhip snakes, *Coluber flagellum flagellum*, subjected to the extreme environmental conditions of the thermal chamber.

conclusion of 99.5 hours, but the body was rigid and the snake had difficulty crawling when it was liberated.

After being subjected to 99.5 hours in the chamber, with the relative humidity at 37 per cent and the air, as well as the cage, at 38°C ., the snake had lost only 73.8 grams (11.3 per cent of the initial body weight). Throughout the experiment only minor

higher body temperatures, even though these were but a few tenths of a degree Centigrade above other reptiles tested. The coachwhip snake was the most resistant to desiccation of the reptiles maintained in the thermal chamber, and it is unfortunate that no records of the critical maximum were obtained. A few data are available for the desert subspecies, *Coluber f.*

piceus, body temperatures of which reach 46° C. or even 47° C. before the reptile dies. Few other snakes tested thus far are able to survive when the cloacal temperature reaches 44° C., and many are killed when the body temperature reaches 40° C. Therefore, there is some indication that *Coluber flagellum* is better adapted in this respect for a hot, dry environment than are other serpents. More data are needed to demonstrate satisfactorily that the species is better equipped for survival in arid regions than are other diurnal terrestrial snakes, but the information available is suggestive.

Rapid locomotion is an element of importance in the existence of snakes living in deserts, since they are able to move from one source of shade to another before body temperatures reach the critical maximum. Rodent burrows, rock crevices, or shrubs provide protection from solar radiation, as well as a cooler substratum. If the snake can move from one retreat to another with sufficient rapidity, it is possible for it to be

abroad during the day in desert regions where shelter is relatively sparse. In the Colorado and Mojave deserts *Coluber f. piceus* is the only snake ordinarily seen in daytime during the summer months. Other serpents inhabiting the same region are forced to estivate, adopt a subterranean existence, or become either crepuscular or nocturnal in habits during the warmer months.

Whether the subspecies of *Coluber flagellum* that occurs in the southwestern deserts is better able to resist desiccation than the eastern race remains to be determined. In desert regions snakes must rely almost entirely upon the moisture content of their prey, in lieu of water, inasmuch as rains are infrequent and highly irregular throughout the deserts. Hence it is of utmost importance that a diurnal terrestrial animal be able to conserve moisture, and it is apparent that *Coluber flagellum* is better equipped to do so than other snakes that have been tested.

DISCUSSION

It is generally recognized that animal life is not equally distributed, and that various habitats or biotopes can be distinguished, each with its characteristic soil, climatic conditions, vegetation, and its animal community. Moreover, it has become apparent that some animals are restricted to one sort of biotope, whereas others are not so exactly adapted and may occur in divers environments. Carr (1940), in his extremely useful paper on the herpetology of Florida, recognizes over a score of habitats in his analysis of distributions in the state. Each of these habitats, Carr shows, has its characteristic species, but others occur therein either frequently or occasionally. One animal may be abundant in one habitat and uncommon or absent in another. Thus the scrub pine lizard, *Sceloporus woodi*, is "confined to the earliest stages in dune succession—rosemary scrub or treeless dunes," and its distribution is necessarily discontinuous. The indigo snake, *Drymarchon corais couperi*, occurs throughout Florida, in a variety of biotopes, but is most abundant south of

Lake Okeechobee where the substratum is more often moist. Finally, a few species are virtually ubiquitous; such reptiles as *Coluber constrictor priapus* are so widely distributed that it is difficult to say where they are most abundant.

It is evident, therefore, that there are varying degrees of restriction to one or more habitats. In most instances it is possible to do little more than speculate concerning the factors that limit individual species in their choice of biotopes, unless they are confined to caves, to sand dunes, or to other highly specialized environments. Even in such exceptional cases the nature of the restraining factors is not always apparent. An animal living in desert sand dunes may be quite unable to survive in dunes along the ocean because the sand in the latter is not sufficiently fine, or because the thermal requirements of the animal cannot be met. Another animal may live in caves, but it may be restricted to limestone caves, or a flowing stream and a moist atmosphere, coupled with air tem-

peratures of definite extremes, might be additional requirements.

In some instances animals seemingly have become so specialized in their feeding habits that their existence in a given habitat may be dependent upon the presence of suitable prey. Carr (*supra cit.*) reports that only crayfish (*Cambarus fallax*) were found in the stomachs of over a hundred specimens of the mud snake, *Liodytes alleni*, that he examined. It does not follow that *Liodytes* is restricted to marshes, bogs, and sloughs where the crayfish is found, but evidence might be assembled to demonstrate such a limitation.

One factor or another may limit the choices of habitat open to an animal, and it is probable that more often the selection is dependent upon several elements of the environment. As a corollary, the distribution of an animal in turn is dependent upon historical factors as well as the vagility of the species, that is, upon its ability to overcome barriers, whether these be physiographic in a strict sense, or climatological barriers that in many instances are associated with topographical features. Some of the endemics in the peninsulas of Florida, Mexico, and Baja California perhaps are confined to these southern extensions of the North American continent because they cannot tolerate the cold winters of the mainland to the north. Regions with low rainfall are obstacles to the dispersal of some species; distributional data for reptiles and amphibians suggest that many amphibians and reptiles are restricted in their east-west dispersals by the southwestern deserts.

Climatic conditions on each side of the Gulf of California are similar, yet less than half of the species found in Sonora are known to occur in Baja California. Those common to the two regions are principally species that have been able to invade the intervening deserts north of the Gulf. Approximately one-fifth of the amphibians and reptiles found in Sonora are tropical forms. These appear to be confined to the moist barrancas in the southern portion of the state. Seemingly they have failed to penetrate Arizona because of the relatively arid conditions that prevail in the

lowlands in northern Sonora and southern Arizona. High temperatures as well as low humidity may be the inhibiting factors in some instances.

By means of controlled experiments it is possible to gain some notion of the validity of such speculations. The experiments carried out at the Archbold Biological Station were designed to measure the amount of moisture lost under conditions that would permit comparisons of the species tested. Undoubtedly the artificial environment maintained in the thermal chamber was more extreme than that ordinarily encountered by Floridian reptiles. Air temperatures of 38° C., with the humidity at 37 per cent, are often encountered in arid regions, however, and commonly the surface of the substratum exceeds 50° C. in deserts as well as in Florida. Reptiles living under such environmental conditions, of course, are not normally subjected to such extremes for prolonged periods. It has been pointed out elsewhere (Cowles and Bogert, 1944) that through their activities, their behavior, and posture, reptiles are able to control the body temperatures and to maintain them within relatively narrow limits. Only under extenuating circumstances are reptiles unable to seek the necessary shade of burrows, rock crevices, or other places of refuge where temperatures tend to be lower and the humidity is likely to be higher. Reptiles inhabiting regions with scanty vegetation and no outcrops of rock may be forced to burrow into the soil to attain the same ends. On the other hand, species living in aquatic situations supposedly are rarely subjected to high temperatures owing to the thermal capacity of water. Only in times of drought would they find it difficult to maintain sufficiently low body temperatures.

Few aquatic reptiles are strictly confined to water. Indeed some of them can make journeys of some length over dry land, even though such travel more often is carried on during or following heavy rains. Terrestrial species, however, supposedly would find it less difficult to undertake migrations, since land habitats are continuous, whereas aquatic situations,

whether they be streams, ponds, lakes, or marshes, are invariably disjunct. Reptiles able to endure the high body temperatures that result when the temperatures of the substratum as well as that of the air are high, and when water is not available, would be expected to be less inhibited in their migrations and their dispersals than other reptiles. Consequently it is of interest to ascertain whether any correlations exist between a species' ability to survive the high temperatures and the low humidity of the thermal chamber, and the choice of habitat. Any correlations that exist supposedly would be reflected in the ranges of the species.

If extreme cases are considered there appears to be a measure of truth in this supposition. It is noteworthy that the one skink (*Eumeces*) tested lost moisture at an extremely rapid rate and survived for the shortest period of any animal tested. Lizards of the genus *Eumeces* are notably absent from the more arid regions of the United States. In contrast, the coachwhip snake, *Coluber f. flagellum*, which survived longest in the thermal chamber and lost moisture at the slowest rate, is the Floridian race of a species that ranges throughout the southern portion of the United States, inhabiting deserts as well as less arid terrain. In such regions as the Gulf Coast the coachwhip snake seemingly prefers the drier habitats, avoiding dense woods and moist situations. Moreover, *Coluber flagellum* is one of the few reptiles that ranges from coast to coast in the United States. Relatively minor morphological differences serve to separate the subspecies, but it is conceivable that there are more pronounced physiological differences; the subspecies *C. f. piceus*, inhabiting the deserts, may be even more resistant to dehydration than its Floridian relative.

It is evident, nonetheless, that *C. flagellum* has encountered few barriers in its east-west dispersal. The range of *Coluber constrictor* is less readily interpreted upon the basis of the results obtained in the experimental chamber. Whereas this snake was not quite so resistant to desiccation as *C. f. flagellum*, it was capable of surviving

the extreme conditions of the thermal chamber for a prolonged period. Its hardiness is reflected in its wide distribution in Florida, but in the western portion of the United States the species does not occur in the truly arid regions. It is found as far north as Canada, while *C. flagellum* is restricted to the southern half of the United States, ranging barely north of latitude 40° in Nevada. The distributional data suggest a somewhat lower temperature preference for *Coluber constrictor*, which would explain its absence from the deserts despite its ability to resist desiccation. *Coluber flagellum* is normally active only when its body temperature lies between 27° and 35° C., and it will voluntarily tolerate 37° C. on occasion (Cowles and Bogert, 1944, p. 284), but there are no data available concerning the activity range of *Coluber constrictor*.

The third species of snake tested, *Drymarchon corais*, survived the extreme conditions of the experimental chamber for a relatively brief period and lost weight at an extremely rapid rate. These results offer some explanation for the abundance of the indigo snake in moist habitats, and because such habitats are more abundant in coastal plains, the restriction of the range of the species to the coastal plains of the United States can be attributed, in part at least, to the physiological requirements of the species. Thermal factors supposedly prevent the indigo snake from ranging north of the Carolinas, and the temperature extremes, as well as the aridity of the Mexican Plateau, may be responsible for the restricted range of *Drymarchon* in Mexico. The aridity of the land bordering the Colorado River in the Southwest presumably antedated the western dispersal of the species; had *D. corais* succeeded in reaching California or Baja California it is probable that colonies would have survived in some of the moist localities.

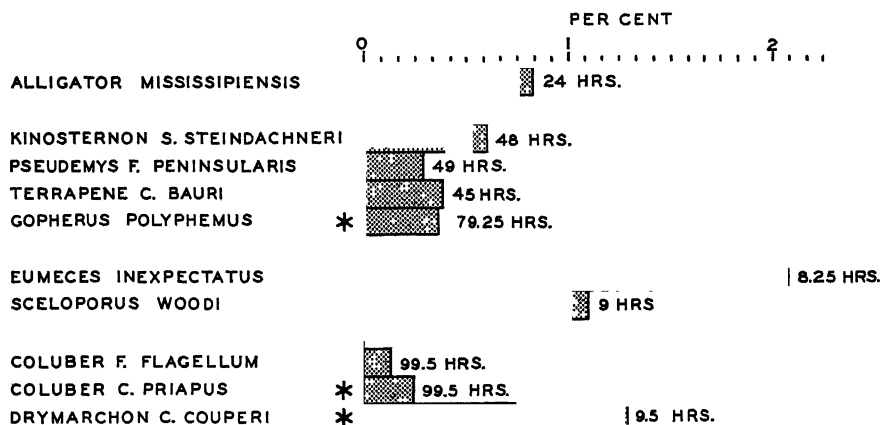
Regardless of historical factors, however, there is evidently a rough correlation between the preferred habitats of the three snakes tested and the ability of each to withstand the extreme conditions of the experimental chamber. *Drymarchon*, with a marked preference for a moist substratum,

survived the shortest period and lost weight rapidly. The ubiquitous *Coluber constrictor* was relatively hardy, but not so well able to resist desiccation as *Coluber flagellum*, a species that prefers the most arid habitats available to it in Florida.

In terms of their moisture requirements one snake can apparently be compared with another. But it is doubtful whether the reptiles of one group can be compared with those in other groups. It is manifest,

easily be detected by histological examination, and Noble and Mason do not state how they arrived at their conclusion.

The results of the experiments described above demonstrate that when the rate of loss is expressed as a percentage of the body weight, some snakes lose water much more slowly than any of the four turtles tested. The horny layer of the epidermis of chelonians, particularly of *Gopherus*, is thicker than it is on any of the snakes used in ex-



PERCENTAGES OF INITIAL BODY WEIGHT LOST PER HOUR BY TEN FLORIDIAN REPTILES (MEAN RATE OF LOSS FOR THE PERIOD OF TIME INDICATED) UNDER CONDITIONS OF VIRTUALLY CONSTANT TEMPERATURE (38°C) AND RELATIVE HUMIDITY (37%). AN * INDICATES SPECIES THAT DIED IN THE PERIOD

Fig. 23. Comparisons in the rate of moisture loss (in terms of the percentage of the initial body weight lost) of 10 species of Floridian reptiles used in experiments.

for example, that the surface area per unit weight is much less in turtles than it is in snakes. Moreover, since moisture is lost through the lungs as well as through the skin, the extent of the area of the lung surface would have to be taken into account. Noble and Mason (1932) report that there is little correlation between water loss and skin structure, except that the most impervious skins are provided with the thickest horny layer. It is doubtful, of course, whether physiological differences could

perments. Since the surface-volume ratio is considerably higher for snakes than it is for tortoises, it is a fair assumption that, as far as the lungs or the skin is concerned, there are physiological differences between the two types of reptiles. Because the relationships between moisture loss and habitat selection involve such factors it seems preferable to confine comparisons to species in one order or suborder. Even though the two lizards used in experiments were taken in the same habitat

(they sometimes occur side by side), the skink (*Eumeces*) is not ordinarily seen moving about except in heavily shaded areas. Usually it is found in moist places under logs, boards, or decaying plant material, whereas the scrub pine lizard (*Sceloporus*) is abroad in open areas throughout the day. The amphisbaenid (*Rhineura*) was not tested under similar conditions, but its seeming inability to venture to the surface and its restriction to moist sand are quite in keeping with the fact that it died within a few hours when kept in dry sand at room temperature.

Turning now to the turtles it is instructive to note that the species (*Kinosternon subrubrum*) that lost water most rapidly is among the most aquatic of Floridian turtles, and that it is rarely seen on land. It lost moisture in the experimental chamber much more rapidly than the terrestrial *Gopherus*, and *Terrapene*. Not so easy to explain is the hardness of the *Pseudemys*. The "cooter" is essentially an aquatic turtle, even though it often wanders about on the land. This ability to remain on land for prolonged periods may account for the wide dispersal of the genus. Few groups of chelonians are quite as widespread in North America, although *Pseudemys* is surpassed in a few respects by *Kinosternon*, some species of which are also given to semi-terrestrial habits. *Gopherus* in Florida has recourse to its moist burrows, and *Terrapene* commonly buries itself in humus or beneath the roots or overhanging branches of shrubs during its inactive periods. *Pseudemys* apparently relies upon its ability to reach water before seeking protection from desiccation.

As a group, turtles are probably resistant to dehydration in spite of the fact that relatively few species are completely terrestrial. The persistence of turtles since the Mesozoic, despite their conservative evolution, may perhaps be attributed to their structural peculiarities; their compact bodies and their cornified exteriors may have evolved in response to other requirements, but thus equipped the turtle was able to survive climatic changes that led to the extinction of the dinosaurs and decimated the crocodilians.

The American alligator is the only member of its group that could be tested, but it is readily apparent that an animal of such proportions must have frequent recourse to water if it is to survive. A creature that within 24 hours loses 20 per cent of its body weight under conditions maintained in the thermal chamber is manifestly not suited for conditions that prevail in arid regions. Permanent water and shade and an adequate food supply are conditions that could readily be met only in a moist, semi-tropical region. Only along the Gulf Coast in the United States do such conditions prevail. The arid regions in western Texas with little cover and high summer temperatures are doubtless an insuperable barrier to crocodilians.

Audova (1929) suggests that during the transition from the Paleozoic to the Mesozoic reptiles may have suffered from increasing dryness. Nopcsa (1924) before him had indicated that increasingly arid climatic conditions had been a major factor in the extinction of the dinosaurs. However, both Nopcsa and Audova, as well as the majority of the paleontologists, have attributed widespread extinctions to a general lowering of the temperature. Cowles (1939, 1940, and 1945) disagrees, pointing out the susceptibility of present-day reptiles to high temperatures.

Audova intimates that primitive reptiles were more thermophilic than modern reptiles, but this statement is not borne out by recent investigations. Contrary to widespread notions the highest environmental temperatures are not encountered in the tropics, but in the so-called temperate zone. The reptiles inhabiting moist tropical climates are less able to withstand high temperatures than those of the arid regions; the few data available indicate that lower temperatures are preferred by reptiles living in the tropics. Noteworthy in this respect is the restriction of existing giant reptiles to tropical or insular environments where they are not subjected to extremes of temperature. The tuatara (*Sphenodon*), a relict of an ancient group, survives only in the islands around the Bay of Plenty off the coast of New Zealand in a relatively cool but moist climate.

Thus increasing aridity coupled with greater extremes of temperature seems to have driven the more primitive reptiles into moist habitats, either in the tropical or semi-tropical regions, or to insular habitats where the climate is tempered by the thermal capacity of the surrounding water. Crocodylians and marine turtles, the largest reptiles in existence, must have survived when other gigantic reptiles became extinct because their moisture and thermal requirements were more readily met in an aquatic environment. Bulk evidently is disadvantageous to ectothermic terrestrial animals subjected to extremes in temperature, if for no other reason than the difficulties that a large animal encounters when it must seek shelter.

Although the body temperature of rep-

tiles is depressed somewhat as a result of water loss, it is doubtful whether the cooling from evaporation is of great ecological importance under ordinary conditions. Under extenuating circumstances respiratory cooling undoubtedly has survival value. But the relatively slow rate of dehydration characteristic of terrestrial and arboreal reptiles under field conditions must be of far greater importance in that it enables them to survive periods of deficient rainfall. Similarly the reptile's ability to absorb moisture through its skin obviates the necessity for drinking during periods when water is otherwise inaccessible. The forms that live in dry environments are able to do so, not because they can absorb water, but because they do not lose it rapidly.

SUMMARY

Ten species of Floridian reptiles were subjected to nearly constant environmental temperatures of 38° C. in an experimental chamber in which the relative humidity was maintained at a level approximating 37 per cent. An additional species, a subterranean lizard, was subjected to wet and dry sand at room temperatures. The experimental animals were weighed at periodic intervals during

their exposure to such extreme environmental conditions, and those that survived were returned to a moist environment and weighed again. A few reptiles maintained in the thermal chamber in closed containers with wet sand in the bottom lost no weight so that it could be relatively certain that loss in weight represented a loss of moisture.

CONCLUSIONS

1. Under similar environmental conditions there are marked differences between various species of reptiles in their ability to resist desiccation.

2. Aquatic reptiles or those that habitually live in damp sites lose moisture at a more rapid rate (in terms of the percentage of their original body weight) than those commonly found in dry habitats. There is therefore a definite correlation between habitat selection and the ability to resist desiccation.

3. Although the Floridian race of each wide-ranging species was the only one tested, a rough correlation was found to exist between the ability of representatives of the species to resist desiccation and the

vagility of the species, particularly when comparisons are restricted to species belonging to one major group.

4. The reptiles tested with reference to the phenomenon are able to absorb moisture through their skins when in moist sand, and lose moisture when in dry sand. Immediately prior to ecdysis the rate of moisture loss in snakes is greatly accelerated; death results if they are subjected for relatively brief periods to environmental temperatures of 38° C., with the relative humidity at 37 per cent.

5. The evolutionary implications of moisture loss in relation to habitat selection are discussed, and it is suggested that increasingly arid climatic conditions during

the transition from the Paleozoic to the Mesozoic may have been a factor of importance in the extinction of the dinosaurs. However, distributions of the largest existing reptiles imply that increasingly high (rather than low) temperatures can more

readily account for such extinctions, despite the beliefs of competent paleontologists. The most primitive existing reptiles tend to prefer moist environments where moderately low temperatures without great extremes prevail.

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ATRYTONE SINGULARIS HERRICH-SCHÄFFER AND THE SUBSPECIES INSOLATA BUTLER (LEPIDOPTERA, RHOPALOCERA)

BY ERNEST L. BELL

In the year 1865 Herrich-Schäffer described a species of Hesperidae from a single male specimen collected by Dr. Juan Gundlach in the vicinity of Guantanamo, Oriente Province, at the eastern end of Cuba, and gave it the name *Goniloba singularis*. Apparently Herrich-Schäffer returned this specimen, the type of the species, to Dr. Gundlach as it is said now to be in the Gundlach collection in Havana, Cuba.

Since the publication of Herrich-Schäffer's description so many years ago, all of the references to his *singularis* in published literature known to us are based on the single specimen collected by Gundlach, and no further captures of this insect have been reported.

Dr. S. C. Bruner, Chief of Department, Departamento Fitopatologia y Entomologia, Estacion Experimental Agronomica, Santiago de las Vegas, Cuba, has recently sent to us four specimens, two of each sex, of *singularis* which were collected at Siboney by Mr. Pastor Anayo, of Santiago de Cuba. Siboney is located on the southern coast of Oriente Province, southeast of Santiago de Cuba and southwest of Guantanamo, the type locality of *singularis*. The specimens were captured on the following dates, one male, June 20, 1943; one male, August 11, 1946; one female, May 9, 1945; one female, June 9, 1946.

Dr. Bruner has generously donated one pair of the specimens to the American Museum of Natural History, and the other pair is being returned to him. In addition to the pair of specimens donated by Dr. Bruner there is another female specimen in the collection of the Museum which bears the label "Cuba Schaus coll." which was

presented to the Museum, among other material, by Dr. William Schaus many years ago. According to Bates, Dr. Schaus collected specimens of insects in the provinces of Matanzas and Oriente.

Gundlach (1881) briefly redescribes *singularis* and says that he collected only one specimen in the vicinity of Guantanamo and that there was nothing known of its origin or its habits. He gives the expanse across the wings as 40 mm.

Ramsden (Skinner and Ramsden, 1923) says that he saw the type of *singularis* in the Gundlach collection in Havana and compares it with *cornelius* Latreille, a related Cuban species.

Williams (1931) does not mention *singularis* in his paper on the Hesperidae taken by Mr. Orazio Querci and his family during their 11 months' collecting in Cuba either among the species that were collected or in the list of those not collected. With headquarters at Cristo, near Santiago de Cuba, most of the collecting by Mr. Querci and his family was done in the foothills of the Sierra Maestra Mountains which lie along the southern side of Oriente Province at the eastern end of Cuba. Williams says that Mr. Querci and his family were in the field every day. Despite this intensive collecting no specimens of *singularis* were taken, although the general region in which the Querci family worked is that from which have come all of the known specimens of *singularis* bearing definite locality data.

Bates, in his comprehensive paper on the butterflies of Cuba, places *singularis* among the doubtful species.

In view of the absence of published records of the capture of specimens of *sin-*

gularis since the original type specimen was taken and the fact that the four specimens sent by Dr. Bruner were collected over a period of nearly three years, it is indicated that the species is of rare occurrence or very locally distributed, or perhaps both.

The unspined mid-tibiae and the general superficial characteristics seem to indicate that *singularis* is closely allied to that section of the genus *Atrytone* in which the primaries of the males have an oblique stigma of similar form but not so greatly developed.

In the original description Herrich-Schäffer briefly compares *singularis* with "*G. lineosa* m. aus Brasilien" but we can find no published description by Herrich-Schäffer of a species of Hesperidae by that name, and we assume that it is a *nomen nudum*.

In view of the brief original description of *singularis* and the fact that the female has not been described at all, we give below a detailed description of both sexes.

Atrytone singularis Herrich-Schäffer

Figure 1

Goniloba singularis HERRICH-SCHÄFFER, 1865, p. 55. Cuba.

Pamphila singularis, KIRBY, 1871, p. 605.

Goniloba singularis, GUNDLACH, 1881, p. 168.

Pamphila singularis, GUNDLACH, 1881a, p. 113.

Goniloba singularis, SKINNER AND RAMSDEN, 1923, p. 318.

Goniloba singularis, BATES, 1935, p. 238.

MALE

The upper side of the primaries is dark brown with a ferruginous sheen. The basal area is overscaled with rusty fulvous. The very broad stigma is dark grayish and composed of two segments, the upper one filling the base of interspace 2 and the lower one extending across interspace 1 to vein 1. These two segments are outwardly bordered by a broad area of modified scales which change in color according to the angle of light in which they are viewed; thus they may appear to be black, or burnished coppery, or metallic green. The fringes are brownish.

The secondaries are dark brown with an overscaling of rusty fulvous except in the costal area and along the outer margin.

The overscaling varies among individuals in its intensity and the area which it covers. The fringes are brown with some fulvous scales in the lower part and at the anal angle.

The under side of the primaries is dark brown with an overscaling of rusty fulvous along the costal margin and on the apical half of the wings. The secondaries are entirely overscaled with rusty fulvous.

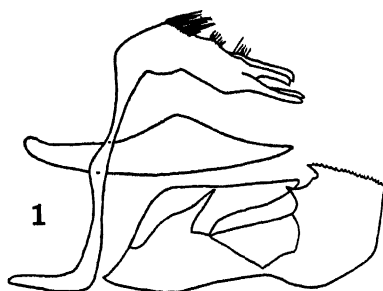


Fig. 1. Male genitalia of *Atrytone singularis* Herrich-Schäffer. Cuba.

The upper side of the head is black with yellow scales in front of the antennae, at the extreme back of the head, and surrounding the third joint of the palpi. The top of the thorax and the abdomen is fulvous and rusty fulvous. On the under side the palpi are yellowish and the pectus is orange fulvous. The thorax and abdomen are fulvous and rusty fulvous. The legs are rusty fulvous. The hind tibiae have two pairs of spurs, the upper pair much smaller than the lower pair. The mid-tibiae are not spined (as mentioned by Herrich-Schäffer). The antennae are about half as long, or a little more, than the costal margin of the wings; the club is moderately stout with an apiculus which appears to be equal to a trifle more than the diameter of the club. The antennae are black on the upper side, and on the under side there is a narrow fulvous line. The club is entirely fulvous; the apiculus is red.

FEMALE

No two of the three females before us are alike, but on the upper side the ground color seems to be a shade paler than that

of the males. The rusty fulvous overscaling is of the same shade and covers about the same area as that of the males. One individual has two slightly yellowish hyaline discal spots on the primaries, an elongate one in interspace 2 just under the end of the cell, and the other a smaller one lying near the base of interspace 3. There is a barely noticeable indication of a subapical spot in interspace 6. Another individual has the two spots in the same positions, but the lower one is very small and the upper one so minute that it is just discernible. The third individual appears to have no spots at all, a minute paler place in the ground color being the only trace of the spot in interspace 2.

On the under side of the wings the rusty fulvous overscaling appears to be heavier and more extensive than that of the males. As on the upper side, the three females differ from each other on the under side. The first individual mentioned has the two discal spots of the primaries slightly larger than on the upper side, but the subapical spot is very small. On the secondaries there is a hazy indication of two small discal spots, one in interspace 2 and the other in interspace 3. The second individual has the two discal spots of the upper side and they are slightly larger. In the third individual the spot in interspace 2, only indicated on the upper side, is small but plainly present on the under side, and there is a very minute spot in interspace 3.

LENGTH OF ONE PRIMARY WING: Male, 17 mm.; female, 19 mm.

Plötz (1884, p. 284) placed "*singularis* HS. i. 1." as a synonym of *Thymelicus waco* Edwards, and Godman (1907, p. 146) erroneously treated this manuscript name as *Goniloba singularis* Herrich-Schäffer. Draudt (1923, p. 928, pl. 180d) followed Godman's error. *Thymelicus singularis* Plötz has been placed as a synonym of *Copaodes aurantiaca* Hewitson by other authors.

Atrytone singularis subspecies *insolata* Butler

Pamphila insolata BUTLER, 1878, p. 483. Jamaica.

Hesperia aurinia PLÖTZ, 1883, p. 195. Jamaica.

Serdis aurinia, LONGSTAFF, 1908, p. 50.

Limochores aurinia, DRAUDT, 1924, p. 935, pl. 181k.

Limochores insolita, KAYE, 1926, pp. 459, 498.

Limochores insolita, KAYE, 1931, p. 536, pl. 39, fig. 11.

Limochores insolita, AVINOFF AND SHOUMATOFF, 1946, p. 293.

As there are some superficial differences in specimens from Jamaica and Hispaniola we retain the name *insolata* to represent the subspecies of *singularis* inhabiting those islands. The overscaling on both sides of the wings of both sexes of *insolata* is of a lighter shade of fulvous, and in some individuals, especially those from Hispaniola, it is particularly bright. On the under side of the secondaries occasional individuals of each sex show traces of a curved discal band of small pale spots which vary in distinctness.

On the under side of the primaries of the males the stigma of the upper side is represented by a prominent black area which is outwardly bordered by accumulations of pale fulvous scales forming spots in interspaces 1 and 2, and a small spot in the base of interspace 3. These three spots appear to form a discal band which is not present on the upper side of the wings, and they are not present on the under side of the wings of the two males of *singularis* from Cuba.

The discal spots in interspaces 2 and 3 of the upper side of the primaries of the females average larger than those of the females from Cuba which we have before us. One specimen from Haiti has the two discal spots more developed than usual, and in addition to them there is another small but distinct semihyaline spot in interspace 1 obliquely inward of the large spot in interspace 2. This individual also has two elongate subapical spots, the lower slightly larger than the upper one. The three females from Jamaica all show a small subapical spot, and 24 of the 26 females from Hispaniola show from one to two subapical spots which individually vary in size and distinctness. The other two females entirely lack them. On the under side of the wings the subapical spots are usually smaller and sometimes less distinct than on the upper side.

The figure of the female from Jamaica

published by Kaye (1931) shows two well-developed discal spots on the primaries but no trace of subapical spots on either the upper or the under side.

Butler says in his paper that the Lepidoptera listed therein were collected at or near Kingston, Jamaica; thus the type of his *insolata* came from that region.

Longstaff says that he collected two specimens, one of each sex, of *insolata* at the foot of Park Mount, Port Antonio, Jamaica. He identified them at first as *Serdis aurinia* Plötz, but in a footnote says that Mr. H. H. Druce found Butler's type of *insolata* (labeled "*Pamphila insolita*") in the British Museum and that a comparison with it showed his specimens to be identical, Butler's name having priority.

The fact that the type specimen is labeled "*insolita*" accounts for the name's having appeared in literature in that spelling; however, in the published description it is spelled "*insolata*."

Avinoff and Shoumatoff mention various localities for their captures of *insolata* in the parishes of Portland, St. Thomas, Clarendon, Manchester, Trelawney, and Westmoreland, Jamaica. They say that the species occurs in open arid places and is rare.

We also have specimens from the parishes of St. James and St. Ann. These various parishes are located in the three counties comprising Jamaica: Portland, Kingston, and St. Thomas parishes are in Surrey County at the eastern end of the island; Clarendon, Manchester, and St. Ann parishes are in Middlesex County in the center of the island; Westmoreland, Trelawney, and St. James parishes are in Cornwall County at the western end of the island.

The definite dates of capture of the Jamaican specimens we have include the months of February, March, April, and July.

From the foregoing records it appears that *insolata* is generally distributed over the entire island of Jamaica, but it does not seem to occur in abundance in any of the localities where it has been taken.

In Hispaniola *insolata* appears to have a wide distribution and to occur more abundantly than it does in Jamaica. We have before us a series of 73 specimens from Haiti and nine from the Dominican Republic. In Haiti the localities from which the specimens came are: Aux Cayes, Bize-ton, Carrefour, Fond Parisien, and Petionville; and in the Dominican Republic from Sanchez, Samana, and Puerto Plata. The dates of capture include each month from January to June inclusive, September, and December, although not all are in the same year. Thus it would seem that *insolata* is on the wing in this island throughout most, if not all, of the year.

The length of one primary wing for the Jamaican specimens is: male, 18 mm.; female, 19–20 mm.; and for the Hispaniolan specimens: male, 16–20 mm.; female, 19–21 mm. The male genitalia of *insolata* do not materially differ from those of *singularis*.

In this paper where reference is made to the venation by number it follows the English system of numbering each vein from the lowest one upward.

All of the specimens that we have described in this paper, except the two from Cuba being returned to Dr. Bruner, are in the collection of the American Museum of Natural History.

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A REVIEW OF THE DICAETIDAE

By ERNST MAYR AND DEAN AMADON

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INTRODUCTION

The last comprehensive revision of the entire family of flowerpeckers (Dicæidae) was published in 1885 (Sharpe). Not only have numerous new species and subspecies been described during the past 60 years, but the whole concept of the species has been revolutionized since then. A general review of the family is therefore urgently needed. Recent work by Mayr (1941) on the New Guinea flowerpeckers, by Mayr (1945) and by Delacour and Mayr (1946) on the flowerpeckers of the Philippines, by Delacour (1946, 1947) on the flowerpeckers of Malaysia, and by Hindwood and Mayr (1946) on the genus *Pardalotus* has cleared up some of the taxonomic difficulties in this family. Others, particu-

larly the puzzling relationship of certain species in the Lesser Sunda Islands, are discussed in the present paper. Finally, the attempt has been made to form some general conclusions on the evolutionary history of this family.

Original quotations and full synonymies are not given since they are easily available in various ornithological lists and handbooks. However, when possible, reference has been made to the habits and the ecology of the various species. The senior author has had field experience with various species of Dicæidae in New Guinea and the Solomon Islands, and the junior author in the Philippines. All the illustrations are by Alexander Seidel.

THE FAMILY DICAETIDAE

This family of seven genera and 54 species (in about 40 superspecies) of passerine birds is restricted to the Oriental and Australian regions. Flowerpeckers are birds of small or, rarely, medium size, frequently of bright and varied colors. The plumage is often glossy but only rarely metallic. Some have bristles around the gape and nostrils, and hair-like plumes on the nape and occasionally on the flanks. They are without wattles or bare areas of skin on the head, and only one aberrant

species (*Paramythia*) is crested. The edges of the bill are frequently serrated. The tenth (outer) primary is visible, though small, in the primitive genera and vestigial in the others. The legs are short; the toes and claws stout; the tarsus is either scutellated or almost booted; the nostrils are partly covered by an operculum. The more typical genera *Anaimos* and *Dicaeum* which contain 41 of the 54 species feed about flowers on nectar and insects (hence their name flowerpeckers), and the bill is

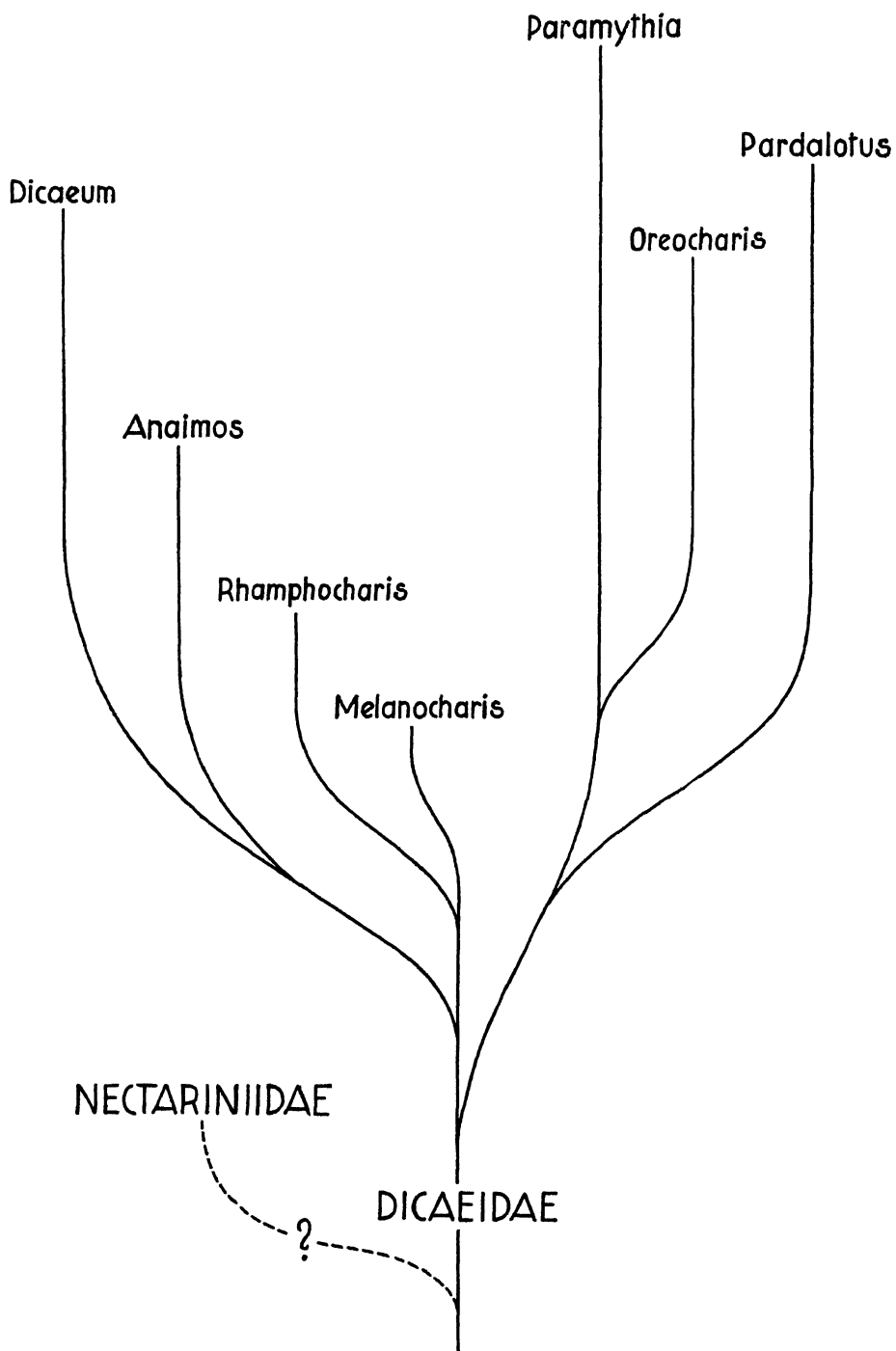


Fig. 1. Diagrammatic phylogeny of the genera of Dicaeidae.

sometimes decurved and the tongue tubular in correlation with these habits. These two genera also feed much on the berries of parasitic mistletoes. The other

genera are rather diverse in habits, as pointed out in the following section.

The supposed phylogeny of the genera is given in figure 1.

POSITION OF FAMILY

Three families, the Meliphagidae (Australian honeyeaters), Nectariniidae (sunbirds), and Zosteropidae (white-eyes), are often thought to be related to the Dicaeidae, but the evidence is rather slight. All four families (at least in some genera) take nec-

tar and small insects from flowers. The Nectariniidae and Zosteropidae are well represented in the Old World tropics both in Ethiopian and Oriental regions and have a few stragglers in the Australian region, especially the Zosteropidae which have undergone considerable evolution in Poly-

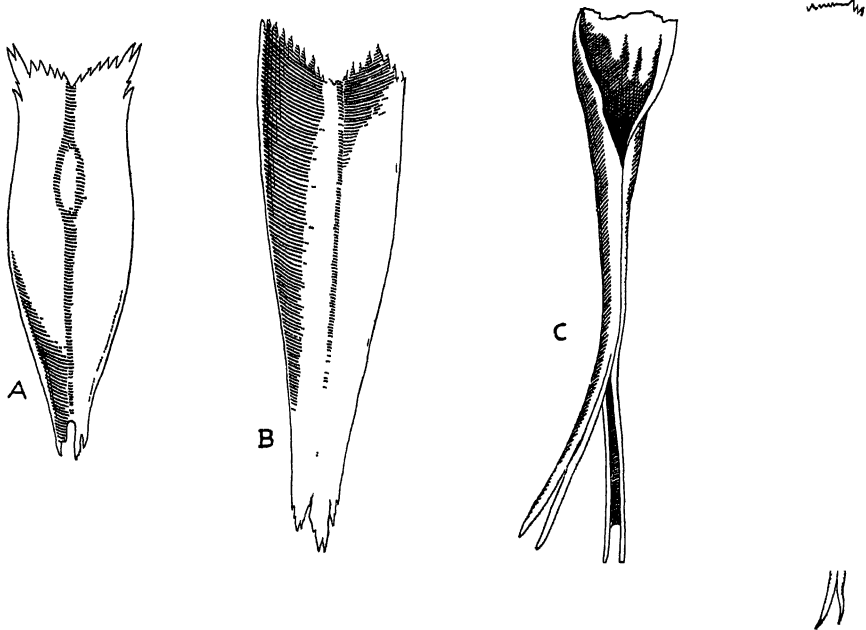


Fig. 2. Tongues of three flowerpeckers (A-C) and a sunbird (D). A. *Milanocharis nersteri*, $\times 5\frac{1}{2}$. B. *Paramythia montium*, $\times 5\frac{1}{2}$. C. *Dicaeum trigonostigma* (after Gadow). D. *Nectarinia* (*Leptocoma*) sp. (after Gardner).

tar and small insects from flowers. The tongue and bill are variously modified for this habit, especially in the honeyeaters and sunbirds, less so in some flowerpeckers and white-eyes. The tenth (outer) primary is always evident in the Meliphagidae and Nectariniidae, present or absent in the Dicaeidae from genus to genus, and always absent (vestigial) in the Zosteropidae. The Meliphagidae are typical of the Australian region, extending even to Hawaii but barely reaching Bali and Celebes. The

nesia and the Solomon Islands. The Dicaeidae seem to have been originally Papuan, but reached the East Indies and Philippines early, where many species have evolved. The Nectariniidae may well represent an offshoot of stock similar to *Dicaeum*. In both, the nest is a specialized pensile bag with side entrance which, together with other resemblances, is probably significant (see also Delacour, 1944).

We have examined the tongues of two specimens of *Paramythia* (fig. 2). The

tongue is triangular, somewhat concave dorsally and with a small notch at the tip. Ventrally there is a vaguely indicated depression or line extending back from the split at the tip. In two specimens of *Melanocharis* the tongue is similar but perhaps slightly more split at the tip (fig. 2). The tongue of these two genera is of a generalized type, in keeping with their frugivorous habits. In the two species *Dicaeum hirundinaceum* and *D. concolor* examined by us the notch at the end of the tongue is deeper, and each of the two tips resulting is semitubular. In *D. trigonostigma*, as figured by Gadow and reproduced in our figure 2, each of the two tips is slightly split to form "four equally-sized semitubular projections without the slightest indication of lacinated or frayed-out margins. . . ." (Gadow, p. 235). Gadow represents the edges of the tongue behind the split tip as meeting dorsally to form a tube. In the two species we examined only a semitube is indicated, but perhaps in life the edges are brought together, forming a complete tube.

Gardner (1925, p. 26) wrote as follows: "The Dicaeidae have small tongues that are flat posteriorly but at about the middle become abruptly narrower and begin to curl into a semitube which is deeply cleft at the tip, the margins of which are smooth, forming two slender semitubular tips. This is found in *Dicaeum cruentatum*, *D. sanguinolentum*, *D. flammeum*, and *D. celebicum* [and according to our findings in *D. hirundinaceum* and *D. concolor*]. In *Acmonorhynchus* [= *Dicaeum*] *aureolimbatus* the same holds true except that the edges of each tube show a slight notching, with an attempt at the production of four tips, while in *Prionochilus* [= *Anaimos*] these notches have deepened to actual splitting with the formation of four semitubular fringeless projections." Gardner mentions Gadow's description of *D. trigonostigma* as representing another type of modification.

In summary, the tongues of *Dicaeum* and *Anaimos* are modified in a characteristic way for sucking nectar, and at the same time resemble the simpler tongues of the fruit-eating flowerpeckers from which

they could readily have evolved. The tongues of *Melanocharis* and *Paramythia* do not differ significantly from those of many passerine birds. The tongue seems to be of little taxonomic value except in genera or families where it is much specialized.

Two or three types of tongues occur in the Nectariniidae (Delacour, 1944). In one type, found in *Nectarinia* and other genera, the basic pattern is similar to that of *Dicaeum hirundinaceum* (or similar species), but the tongue is greatly elongated, very thin, and much rolled so that not only the tip but most of the tongue is conspicuously tubular. The tip is split as in *Dicaeum*, with two tubular projections. We see no reasons why the tongue of sunbirds could not represent a greater modification of the type found in *Dicaeum*. A tongue of *Nectarinia* figured by Gardner is similar to one we have examined and is reproduced in figure 2.

In the Meliphagidae the tongue is very brush-like at the tip and split into four distinct tips and hence considerably different from that of any genus of Dicaeidae. Some New Guinea genera of meliphagids resemble *Melanocharis*, but in view of their difference in habits, this is probably parallelism.

Gadow considered the dorsal feather tract of *Dicaeum* very similar to that of the swallows (Hirundinidae), but the families can scarcely be closely related in view of the many great differences between them.

The purse-shaped nests of *Dicaeum* are quite similar to those of the penduline titmice (*Remiz*). Delacour (1944, p. 19) has suggested that *Cephalopyrrus flammeiceps* of southeastern Asia may provide a link between *Remiz* and *Dicaeum*. *Cephalopyrrus*, which is usually placed with the titmice, nests in holes in trees. The females are very similar to those of *Remiz*. It will require further anatomical and life history studies to determine whether *Remiz* is really related to *Dicaeum*, or merely builds a similar nest. It is also a moot question whether *Remiz* is closely related to the true titmice (*Parus*).

Sharpe (1885, p. 2) associated the waxwings (Bombycillidae) with the Dicaeidae.

Despite some morphological similarities, these families differ considerably in habits and distribution. The relationship of the Bombycillidae to the Neotropical Ptilonotidae is more certain, and has led Stresemann to unite these families. It is conceivable but unlikely that the Bombycillidae provide a northern link between the Ptilonotidae and Dicaetidae. The similarity to the Hirundinidae emphasized by Gadow is of equally doubtful significance.

A few genera have been erroneously or doubtfully allied with the Dicaetidae. The Hawaiian Drepanidae are now considered to be of American derivation. Two

African genera, *Pholidornis* and *Parmophtila*, placed by Sharpe with the Dicaetidae, have been considered by Chapin to be aberrant Ploceidae and by Bates (and more recently Delacour) perhaps to comprise, along with another monotypic genus, *Hylia*, a separate family. We have examined all three and agree with Chapin and Bates that they have nothing to do with the Dicaetidae.

From the above it is only too apparent that much anatomical work is needed before the relationships of the Dicaetidae to other families is placed on a sound basis.

DISTRIBUTION OF THE DICAETIDAE

New Guinea and the Philippine Islands are the home of the greatest number of species. In the east the family extends as far as the Solomon Islands, in the south to Australia and Tasmania, in the west and north to south China and northwest India.

The number of genera and species of Dicaetidae in selected areas is as follows. Some species occur in several of the areas listed.

Ceylon: *Dicaeum*, 3
 Southern India: *Dicaeum*, 3
 Eastern and northern India, northern Burma: *Dicaeum*, 7
 Malay Peninsula: *Anaimos*, 3; *Dicaeum*, 6
 Borneo: *Anaimos*, 4; *Dicaeum*, 6
 Palawan: *Anaimos*, 1; *Dicaeum*, 2
 Luzon and Mindanao: *Anaimos*, 1; *Dicaeum*, 8
 Celebes: *Dicaeum*, 3
 Timor: *Dicaeum*, 3
 Flores: *Dicaeum*, 4
 Australia: *Dicaeum*, 1; *Pardalotus*, 6
 Tasmania: *Pardalotus*, 3
 New Guinea: *Melanocharis*, 5; *Rhamphocharis*, 1; *Oreocharis*, 1; *Paromythia*, 1; *Dicaeum*, 1 (superspecies)
 Solomon Islands: *Dicaeum*, 1 (superspecies)

The generic distribution may be further summarized as follows: In Australia and Tasmania there is one aberrant genus (*Pardalotus*) containing seven species and *Dicaeum* with one species which is a recent immigrant from the Lesser Sunda Islands. In New Guinea there are two primitive genera (*Melanocharis* and *Rhamphocharis*) containing six species and two specialized, monotypic genera (*Oreocharis*, *Para-*

mythia). The latter two resemble *Pardalotus* in some respects but are more like *Melanocharis* in habits. One superspecies of the wide-ranging *Dicaeum* has also reached New Guinea via the Moluccas and extended through New Guinea to the Bismarck Archipelago and Solomon Islands. In the Philippines, East Indies, and Malay Peninsula there are two closely related genera, *Anaimos* and *Dicaeum*, each containing a number of species. *Anaimos* seems to be more primitive and has fewer species. In tropical Asia only *Dicaeum* is known (except in the Malay Peninsula). The family does not occur beyond India and south China.

These distributional facts contain some clues as to the place and time of origin of the family. The general distribution pattern, as well as the prevalence both of primitive and of specialized genera and species on New Guinea, makes it seem probable that the family was originally a Papuan group. From here the family spread south, producing the *Pardalotus* group in Australia, and west into the Malay Archipelago, giving rise to *Anaimos* and *Dicaeum*.

It is difficult to decide when the Asiatic mainland was reached. The family is fairly well represented in the humid tropical and subtropical parts of the Indo-Chinese countries (Malay Peninsula, Burma, Indo-China), but is drastically reduced in abundance in the more arid parts of India. It

has not spread as far as the Palearctic, Africa, or Madagascar. Although the pronounced aridity of northwest India and Arabia is a comparatively recent phenomenon, it is an open question whether the Dicaeidae arrived so recently in India that they have had no opportunity to spread

into Africa or whether there was always an environmental barrier between Africa and Asia impervious to flowerpeckers. Arid zones obviously are a considerable obstacle to flowerpeckers, as indicated by the poor representation of the family in Australia, adjacent to New Guinea with its rich fauna.

PLUMAGE AND SEXUAL DIMORPHISM

In the primitive genera *Melanocharis* and *Rhamphocharis*, the prevailing coloration of the females is greenish olive. Usually the males are more or less glossed with bluish black above, and they may even (in *Melanocharis versteri*) have a metallic luster. Males of *M. striativentris* are olive green like the females. In *Rhamphocharis* the male is only slightly glossed; the female is brownish spotted above and below with white and thus very different in appearance. This spotting is perhaps foreshadowed in the obscure ventral streaking of *M. striativentris*. In most species of these two genera the tail is spotted with white; otherwise the pattern is very simple.

The coloration varies greatly in the numerous species of *Dicaeum* and *Anaimos*. *D. bicolor* is whitish below and bluish black above, thus resembling some species of *Melanocharis* (e.g., *nigra*). This resemblance is probably indicative of relationship. Females of *Dicaeum* are usually simply colored, often brownish olive above and yellowish green below, even in the more brightly colored species of the genus. In a few species such as *D. concolor*, *D. erythrorhynchos*, and *D. tristrami* the males as well as the females are dull colored, but in some of these, especially *tristrami*, there is little doubt that secondary simplification in coloration has taken place. A few species of *Dicaeum* and *Anaimos* are streaked ventrally, but the degree of streaking varies greatly even among the races of one species (*agile*). In many species bright patches of red or orange feathers occur on the crown, breast, rump, or back, and in one species (*D. annae*) there is a peculiar half-concealed patch of orange feathers on the lower back.

The back in the males is usually dark and more or less glossy. In some species the

blackish coloration has extended around to the underparts. In the brightly colored *D. papuense-haematostictum* superspecies of the Philippines, the female has acquired the bright coloration of the male.

In *Melanocharis versteri* and *longicauda* and in *Rhamphocharis* there are white spots on the tail feathers. It is a moot question whether these are homologous with those occurring in three species of *Dicaeum* (*vincens*, *melanoxanthum*, and *agile*), as in *Dicaeum* the spots are nearer the tips of the feathers. These marks are among many indicating that *melanoxanthum* and *vincens* are related; *agile*, on the other hand, is a rather aberrant species. Small round white spots occur on the tail feathers of some species of *Pardalotus*, but again it is uncertain whether they indicate relationship with other flowerpeckers or are merely associated with the extensive spotting characteristic of the pattern in this genus. Such spots on the tail do not occur in *Anaimos*, *Oreocharis*, or *Paramythia*.

There is little in the coloration of the aberrant *Oreocharis* to suggest the more typical genera of flowerpeckers, although the black head and throat may imply distant relationship to such forms as *Anaimos thoracicus*. *Paramythia* is still more specialized but with unmistakable resemblances to *Oreocharis*. Yellow is conspicuous in the remaining genus, *Pardalotus*, and probably indicates distant affinity with *Oreocharis* and more remotely with the *Anaimos-Dicaeum* group. The white spots on the outer webs of the secondaries in some of the species of *Pardalotus* are especially suggestive of *Oreocharis*. Various combinations of spots and streakings are distinctive of *Pardalotus*, though one species (*quadragintus*) has reverted to a somewhat simpler pattern.

In *Oreocharis* the females are much simpler in coloration than males and not greatly dissimilar to those of some species of *Melanocharis* and *Dicaeum*. In *Paramythia* and some species of *Pardalotus* females have acquired the brighter coloration of the males.

TENTH PRIMARY

The tenth primary is evident, though reduced, in *Melanocharis* and *Rhamphocharis*, two genera which, on the basis of other characters as well as this, are probably primitive. A few species of typical flower-peckers have an evident tenth primary. These we have segregated in *Anaimos*, leaving the others in a presumably slightly more advanced genus, *Dicaeum*. While there is no doubt that the six species of *Anaimos*, with the doubtful exception of *olivaceus*, belong to a natural group, the

generic separation on this basis is less convincing in *Dicaeum*. Thus the peculiar *D. annae* looks like *Anaimos*, but the tenth primary is vestigial, so it must be left in *Dicaeum*. The same seems to be true of *D. anthonyi* (the only species in the family not examined). On the other hand, in *D. melanozanthum* the tenth primary is visible, though smaller than in *Anaimos*. This species is obviously close to *D. vincens*, and we have left it in *Dicaeum*.

The tenth primary is vestigial in *Oreocharis*, *Paramythia*, and *Pardalotus*; these are specialized and rather aberrant genera in other respects. It is somewhat surprising that the four endemic frugivorous New Guinea genera, *Melanocharis* and *Rhamphocharis* on the one side and *Oreocharis* and *Paramythia* on the other, should be so different as regards the tenth primary and most other characters.

HABITS AND ADAPTATIONS

Rand (1942, p. 511) wrote of *Melanocharis nigra unicolor*, "this species was usually found solitary, low in the substage and undergrowth, but once at the 1,200-meter Camp I found numbers of them feeding on fruits high in a forest tree." He also notes that *Melanocharis longicauda* frequents both undergrowth and tall fruit trees. Of *Melanocharis versteri meeki* he adds: "This flowerpecker fed in the substage and commonly in low second growth. It was usually alone, and an active bird with quick movements. Three stomachs examined contained fruit."

Rand (1937, p. 239) found *Oreocharis* usually in parties of up to 20 or more in the lower fruit trees of the New Guinea forest. Sixteen stomachs contained only fruit of several varieties. Usually the fruit had been swallowed whole. The related *Paramythia*, as observed by Rand (p. 241), is also a fruit eater.

Diamond birds (*Pardalotus*) are almost entirely insectivorous. They seek food among twigs and foliage, actively and with a variety of postures similar to those of titmice. Hill (1911, p. 283), however, states

that *P. melanocephalus uropygialis* hunts insects in the flowers of a *Grevillea* and eucalypts, becoming smeared with honey and pollen about the throat and forehead while doing so. This is suggestive of the habits of some species of *Dicaeum*.

Chasen (1939, p. 403) summarized the habits of the species of *Dicaeum* as follows: "Usually they are seen alone; tiny, fat, but very active little birds, darting across the path from one tall flowering bush to another with a sharp *chit-chit-chit*, a sound like two pebbles being tapped together, but often they congregate at the tops of very tall flowering trees and then, through binoculars, the busy birds can be seen flitting like a swarm of hymenoptera about the blossoms on the exposed surface of the forest's canopy. . . . I have known cases in which natives employed for insect-catching in the Botanic Gardens, Singapore, have taken the tiny species of *Dicaeum* in their butterfly nets. They eat small spiders, insects and small berries and are especially fond of the berries of plants allied to the mistletoe. There is a marked partiality for the glutinous fruit of *Loranthus*. Epiphytic plants of tall trees seem to attract

flowerpeckers. The nectar of flowers is also taken as food."

Ali (1931) has made a special study of the role of flowerpeckers in India in fertilizing mistletoes (*Loranthus*) and in spreading their seeds. The flowers of *Loranthus longiflorus* are entirely dependent on nectar feeding birds for fertilization, but sunbirds are much more important in this than flowerpeckers. During the season when they are available, *Loranthus* berries form the principal food of *Dicaeum erythrorhynchos*; at other times it takes the berries of *Phyllanthus*, *Lantana*, and *Viscum* (another mistletoe), and occasionally small spiders. "While on a clump [of mistletoe] the bird hops restlessly from bunch to bunch uttering an almost incessant *chik, chik, chik* which is occasionally varied by a series of twittering notes which might be termed its song. Each berry is first tested between the mandibles; if ripe it is plucked and swallowed, broad end (i.e. where the stalk attaches) first. After it has bolted down three or four berries, one after another the bird retires to the extremity of some bare branch at the top of the host on an adjoining tree and sits quiet for a few moments with the feathers partly fluffed out. . . presently one of the viscous seeds is excreted." The seeds adhere to the branches, thus spreading the parasite. In a later publication Ali (1936 p. 778) mentions finding as many as 27 *Loranthus* berries in the intestines of *Dicaeum erythrorhynchos*.

Although *D. erythrorhynchos* rarely strips the fleshy outer covering from the berries without swallowing them, this method is usual in the thicker-billed *D. agile*. "The berry is plucked and invariably revolved between the mandibles which being thicker and stouter, appear better adapted to this method of eating. The flesh is soon detached and the seed wiped on to a neighboring twig" (Ali, 1931, pp. 148-149). In a later publication Ali and Abdulali (1938, p. 160) wrote of the habits of *Dicaeum a. agile*: "Its food consists largely of the berries of the tree parasites, *Loranthus* and *Viscum*. . . . Other berries such as those of *Lantana camara* and *Bridelia retusa* are also greedily taken, as

well as Peepal and Banyan figs. *Bombax* and *Erythrina* flowers are regularly resorted to for the nectar, and spiders likewise form part [of] the dietary. It utters *chik, chik* as it restlessly hops about the foliage. . . . While thus engaged, it spreads out its stumpy square little tail and screws it nervously edgewise from side to side." Lawrence and Littlejohns (1916) wrote of *Dicaeum hirundinaceum*, ". . . the ripe berry [*Loranthus*] was taken crosswise in the bird's bill, and the soft case split in halves by pressure. The free portion of the case was then dropped, leaving the white berry protruding from the half still attached to the branch. By pressure of this remaining half between the mandibles the seed was forced out sufficiently to allow of its being easily taken in the bill." Nestlings were fed insects when small but before they left the nest were receiving chiefly mistletoe berries. This flowerpecker also eats other types of berries, such as wild cherries. Insects are secured both from flowers and by search among foliage. This species is very restless and usually stays in the tree tops.

W. K. Dammerman (quoted by Chasen, 1939, p. 404, without a reference) wrote: "Bartels found in Java the glutinous seeds of these parasitic plants [*Loranthus*] only in the intestinal tract of the bird, the large seeds being unable to enter the very small stomach, which is found always filled with minute spiders, the chief food of the birds."

Porsch (1929) in his exhaustive study of flower-visiting birds and associated flowers, devotes 15 pages to the Dicacidae, which is, so far as the birds are concerned, a compilation. *Dicaeum concolor sollicitans* has been found with its head smeared with nectar and pollen. Porsch found references to at least five species of *Dicaeum* visiting flowers. The following genera of plants are mentioned: *Loranthus*, *Elytranthe*, *Bauhinia*, *Bombax*.

The habits of the species of *Anaimos* are similar to those of *Dicaeum* so far as known.

FEEDING ADAPTATIONS (INTESTINAL TRACT)

Desselberger (1931) distinguishes two functional categories of intestines among

the Dicaeidae: a more primitive one, exemplified by *Melanocharis*, and a more specialized one, as found in *Dicaeum*.

The intestines of *Melanocharis* are short and wide, a condition typical for fruit-eating birds. The stomach consists of a small, glandular proventriculus and a well-developed muscular gizzard. The stomach of *Paramythia* is considerably larger, but

species consists exclusively of fruit. The anatomy of the related, also frugivorous genus, *Oreocharis*, is unknown.

Desselberger studied several species of *Dicaeum*. He found that the muscular stomach (gizzard) has become a blind sac or diverticulum with a sphincter at its opening. By this means berries (*Loranthus* and others) are shunted directly from

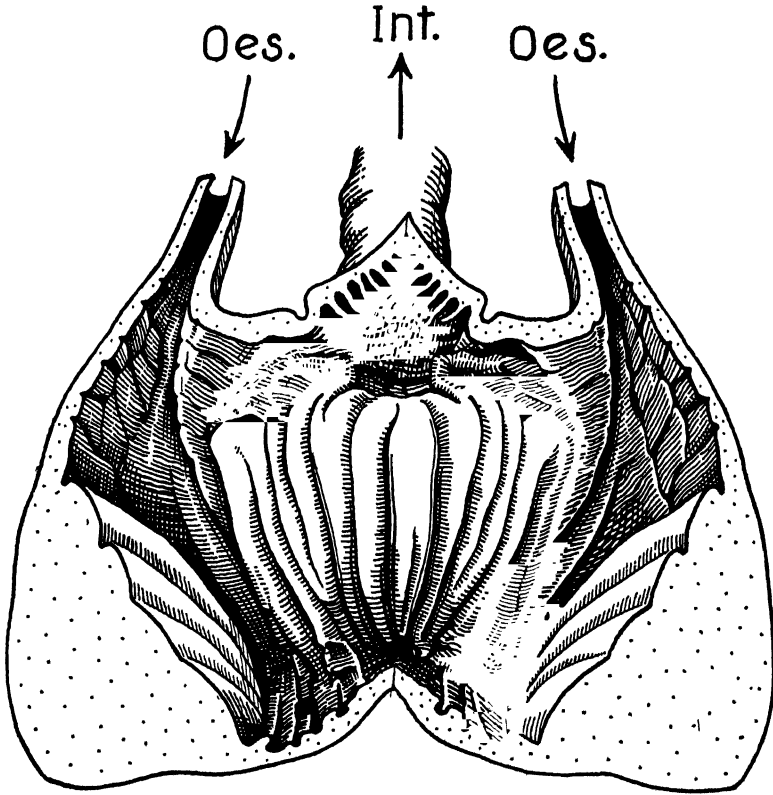


Fig. 3. Stomach of *Paramythia* cut open. Abbreviations: Oes., esophagus; int., entrance to the intestines. (One of the two horny pads was cut when the stomach was opened.)

it is not clear in the examined specimen (Archbold-Rand collection) whether or not the lower end of the esophagus is modified to a proventriculus; it does not appear so. The gizzard is very muscular, with two well-defined pads (fig. 3). The pylorus, which is near the esophageal entrance of the stomach, leads into a wide intestine, the mucous wall of which is modified into innumerable villae. The food of this

the esophagus to the intestine without entering the gizzard. Insects and spiders, on the other hand, enter the gizzard where they are comminuted and the digestible components are removed. This specialization permits large numbers of *Loranthus* berries to pass rapidly through the intestine, where the presumably slight amount of nutriment in their gelatinous capsules is removed. It also avoids the

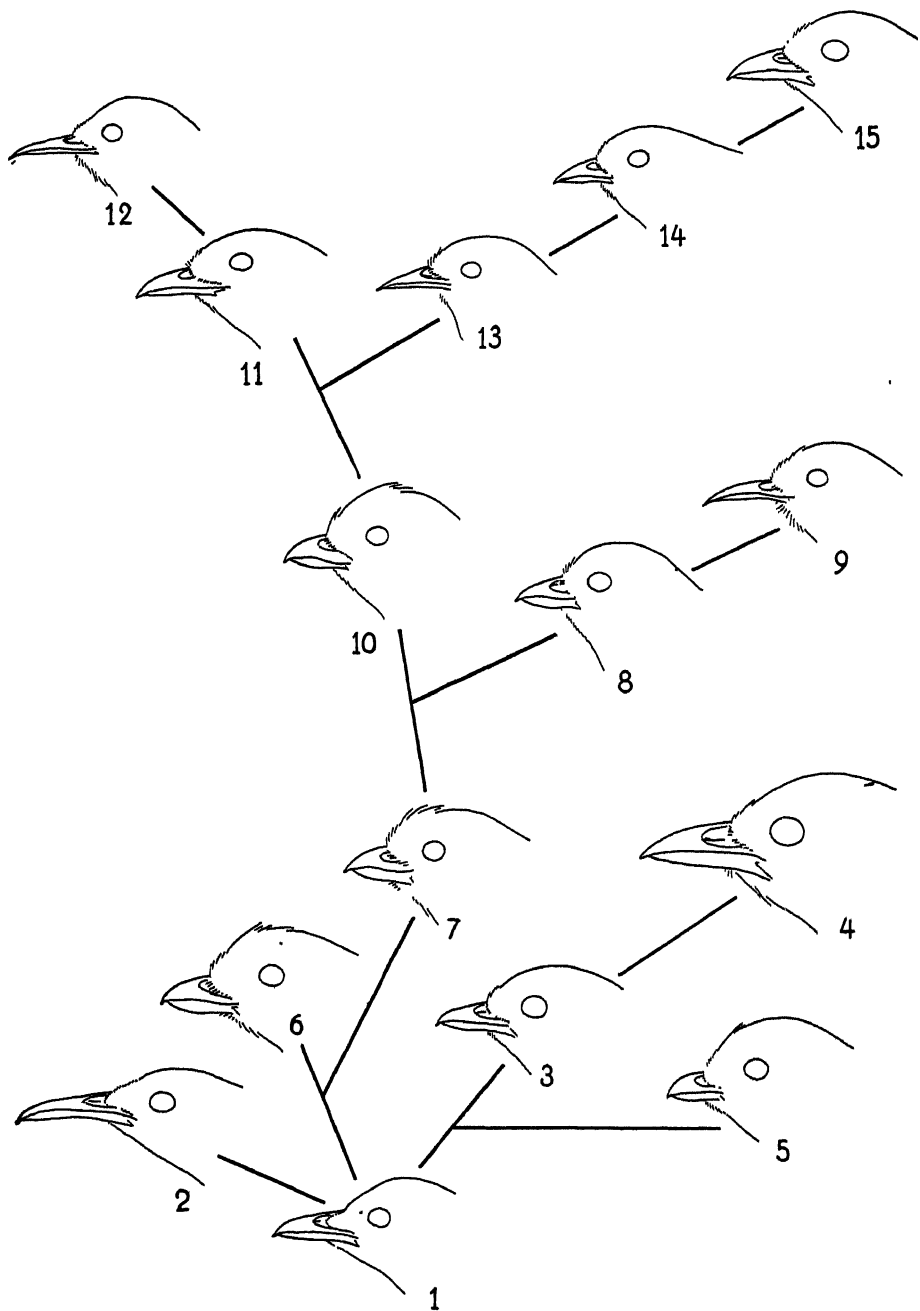


Fig. 4. Rapid evolutionary change of bill shape in the Dicaeidae. 1. *Melanocharis nigra*. 2. *Rhamphocharis*. 3. *Oreocharis*. 4. *Paramythia*. 5. *Pardalotus melanocephalus*. 6. *Anaimos olivaceus*. 7. *Dicaeum agile*. 8. *D. aureolimbatum*. 9. *D. nigrilore*. 10. *D. bicolor*. 11. *D. papuense*. 12. *D. retrocinctum*. 13. *D. nehrkorni*. 14. *D. eximium*. 15. *D. tristrami*. Compare particularly the closely related forms 1 and 2, 8 and 9, 11 and 12, and 13 to 15.

laxative effect on other food that these berries would have if held in the gizzard. Since chitinous parts are not found in the intestines, it appears that they are regurgitated as pellets. This elimination protects the mucous villae of the intestines from injury by sharp-edged chitinous particles. The intestinal tract of *Dicaeum tristrami* studied by us is exactly like that of the other species described and figured by Desselberger. One examined stomach contained 15 spiders, 14 of which were Argiopidae, and one a salticid. The intestines contained remains of berries with very minute seeds (we counted more than 90).

In the tanagers (Thraupidae) of the genus *Tangara* (*Euphonia*), which are thought to feed almost entirely on mistletoe berries of *Phoradendron* and related genera, a different and greater specialization has led to a vestigial condition of the gizzard as a section of the intestinal tract (Steinbacher, 1935).

In *Dicaeum* and *Anaimos* the tongues are, in varying degrees, tubular as in other birds in which nectar is an important item of the diet, as described above.

BILL

In the four fruit-eating genera of New Guinea, the bill is unspecialized, slightly curved, and rather broad basally. In *Rhamphocharris* it is moderately attenuated, but we do not know if this is adaptive.

The bill in *Pardalotus* is stout, arched, and short. Probably it is adapted for digging nesting burrows or enlarging cavities in trees. In feeding, the bill of *Pardalotus* is utilized for taking small insects, their larvae and eggs much in the manner of various titmice, vireos, or other insectivorous birds that have comparatively short, heavy bills.

In the genera *Anaimos* and *Dicaeum* the variations in the bill are greater and often quite puzzling either from a functional or phylogenetic point of view. In some species the bill is very stout and short, scarcely if at all decurved. In others the bill is rather thin and decurved, approaching the condition found in more typically nectar-eating birds such as sunbirds. We

might postulate a gradual adaptation of the heavier bill of fruit- and insect-eating ancestors to permit greater utilization of nectar. This seems to be, in general, true, but there have been frequent reversals of this trend, and both types occur in closely related species. *D. tristrami*, with a heavy, finch-like bill, is a geographical representative of and derived from species in which the bill is thinner. *D. nigrilore* is thin billed but undoubtedly closely related to the heavy-billed *D. aureolimbatus*. In the *papuense-retrocinctum* group of the Philippines there is considerable variation within a superspecies (fig. 4).

It is possible that some but not all of these variations among species of *Dicaeum* may be eventually proved to be correlated with specific differences in food habits. The variation is undoubtedly correlated with the fact that both the seeds of mistletoe and also tiny insects and nectar from flowers are important foods in this genus. Utilization of the bill for opening the pods of *Loranthus* and (at least in *D. agile*) for stripping the gelatinous capsule from the seeds may favor a heavier type of bill. Desselberger, however, found that the alimentary system of the stout-billed *D. aureolimbatus* is modified for the passage of *Loranthus* seeds, so we cannot assume that the stout-billed species are those in which seeds are not swallowed. Apparently consumption of nectar and tiny insects found in blossoms favors a thin, decurved bill (and tubular tongue). On the other hand, utilization of mistletoe berries is probably easier for birds with a stout bill. We may suppose that now one and now the other of these two factors has dominated in the evolution of the various species of the genus, leading to the great variation that exists from species to species. So far as the family as a whole is concerned, the thin, nectar-sucking type of bill and tubular tongue must be considered the more specialized. This type is exclusive in the possibly related specialized sunbirds (Nectariniidae) which feed on nectar and tiny insects but not berries.

The bills of the tanagers (*Tangara*) that feed on mistletoe berries are quite

similar to those of the thick-billed species of *Dicaeum*.

NESTS

The nest of *Dicaeum cruentatum*, which is typical for the genus, has been described by Baker (1934, p. 237) as follows: "They seem to be invariably made of the beautifully soft seed-down of the Simul-tree (*Bombax malabarica*), very little compressed or felted but kept in shape and position by a few shreds of grass, fungoid mycelae or by very fine hair-like roots. The nest is egg-shaped and the materials, other than the down, are used to work round the twig from which the nest is pendent, and from this they are brought down and round the nest itself, a few of the longer strands coming under the nest and up again on the far side. Round the rim of the entrance, which is rather large and at the upper side of the nest, a few grasses are twisted, making it firm enough to withstand the constant passing in and out of the parent bird. Here, too, as on the outside of the nest, cobwebs and silk are sometimes used to strengthen its structure. The lining is of the same cotton-seed down and quite soft when first put in, but soon becoming more or less felted when the eggs are laid and the birds begin to sit."

A nest of *Dicaeum ezimium* from New Britain, which we have examined, is coarser in construction, being made of fine grass ornamented on the outside with pieces of dead leaves. The nest of *Dicaeum vincens* (for a photograph see Lushington, 1940) has "a pronounced hood over the somewhat large entrance." One nest of this species was 75 feet and another 125 feet high in *Dipterocarpus* trees. The nest of *Dicaeum agile* is unusually finely woven and elastic so that it will regain its shape after being rolled up.

A nest of *Anaimos percussus ignicapillus* from Borneo was similar to those of *Dicaeum* (Baker, 1934, p. 249). Coomans de Ruiter (1936) has published a photograph and description of a nest of *Anaimos xanthopygius*. It was only about a meter above the ground but well protected and concealed by large leaves. The walls

were thick so that the chamber scarcely accommodated the two young.

Diamond birds (*Pardalotus*) nest in holes in trees or in banks in burrows which they often dig themselves. They even dig nesting burrows in level sandy ground. They build elaborate nests inside these hollows which are often more or less domed but sometimes cup-shaped. These nesting habits are aberrant, but such birds as the House Sparrow (*Passer domesticus*) or Common Mynah (*Acridotheres tristis*) show that the transition from hole nests to domed nests in the open, or vice versa, is easily effected, sometimes even locally within a species.

The aberrant *Paramythia* builds a bulky, cup-shaped nest among the twigs of thick bushes (Rand, 1942, p. 513). The nests of the other New Guinea fruit-eating genera are unknown.

EGGS

The eggs of *Anaimos percussus* (the only species of the genus for which we have information) are whitish and unspotted, and the same is true of the majority of species of *Dicaeum*. *D. agile* and *D. papuense haematostictum* are known to lay spotted eggs. These species are not closely related. Nevertheless, when the color of the eggs of all species of *Dicaeum* is known it may give some clues to the affinities of the species. It would be interesting to know if *D. bicolor* and *D. anthonyi*, which seem distantly related to *papuense*, lay spotted eggs. Most forms of *Dicaeum*, so far as known, lay two or three eggs. Nests of *D. trigonostigma* in the Malay Peninsula contained but one nestling (Chasen, 1939, p. 407). *Dicaeum concolor* raises two broods (Whistler, 1934, p. 285), and the same has been inferred for other species. The species of *Pardalotus* also lay whitish unspotted eggs, the clutch varying from two to five according to species. *Paramythia* lays one egg which is white spotted with brown (Rand, 1942).

NESTING HABITS

In *Dicaeum vincens* the female builds the nest and incubates; the male helps feed the young (Lushington, 1940). Chand-

ler (1912, p. 132) found that in *Dicaeum hirundinaceum* only the female works on the nest. The male sometimes accompanies her while gathering nesting material, and the male utters a distinctive note in the vicinity of the nest. Both sexes feed the young, at first insects, later mistletoe berries. The male drives other males from the vicinity of the nest (Lawrence and Littlejohns, 1916).

In *Pardalotus* both sexes participate in digging the nest tunnel and probably in building the nest. The male is also said to aid in incubating as well as in caring for the young (Chandler, 1910). Diamond birds are said to be somewhat colonial at times in suitable nesting banks. Roberts (1937), however, noted that the male of a pair of *P. ornatus* feeding young in a hole in a bank repeatedly drove away another pardalote that was hunting a nest site in other holes in the bank.

In *Paramythia* it was observed that only the female incubates, but the male accompanies her when off the nest and aids in feeding the young (Rand, 1942).

VOICE

Typical flowerpeckers have a variety of rather sharp, almost metallic call notes. *D. hirundinaceum* also has a sweet song and a variety of twittering notes. We noticed that *Dicaeum ignipectus luzoniense* has a rather loud warbled song, and the same is probably true of many species of the genus. Pardalotes (*Pardalotus*) have rather monotonous unmusical call notes and also a trill, but little in the way of song. Rand (1937) wrote that the calls of *Paramythia* are low and short but mentions no song. Individuals of *Oreocharis*, when flying in a flock, call a sparrow-like *chip-chip*.

GENERA AND SPECIES OF DICAIEIDAE

The type species of genera are given in parentheses following the name of the describer of the genus. In general, we have not attempted to revise subspecies, and where we have listed them, it is primarily to indicate to what species we believe various forms should be allocated.

MELANOCHARIS P. L. SCLATER (NIGRA)

SYNONYMS: *Neneba* De Vis (*striativentris*); *Pristorhamphus* Finsch (*versteri*); *Urocharis* Salvadori (*longicauda*).

DIAGNOSIS: Tenth primary well developed, the exposed portion being 15 mm. or more in length and almost half the

indistinctly streaked (*striativentris*); upperparts olive green or blue black, often glossy or even metallic (*versteri*); rectrices often with white marks. Edges of bill well serrated. Bill rather short and heavy; culmen moderately decurved. Tarsus with only one or two scutes near base in front, thus almost booted (specimens of *M. versteri* in fluid).

This genus includes the most primitive flowerpeckers. Sexual dimorphism is well developed in several species, with the males more brightly colored but the females larger. Data on the latter point, as given by Mayr (1931, pp. 668-670), are:

SPECIES	WEIGHT (GMS.)		WING (MM.)	
	♂	♀	♂	♀
<i>Melanocharis nigra bicolor</i>	13, 14	15, 15.5, 17	67, 67.5	66, 68, 68.5
<i>Melanocharis longicauda captata</i>	13-15 (13.9)	14-16 (15.4)	64-67 (65.9)	64-67 (65.5)
<i>Melanocharis versteri maculiceps</i>	12.5-15.5 (14.0)	16.5-20 (18.5)	59-64 (61.8)	66-71 (69)

length of the ninth. Tail relatively long, varying from about 75 per cent (*nigra*) to 140 per cent (*versteri*) of the wing length. Color pattern simple: underparts ranging from grayish white through various shades of yellowish or greenish brown, sometimes

The data for *captata* and *maculiceps* are based on series of about six of each sex. The figures for *Melanocharis striativentris* indicate no sexual size dimorphism.

The genus *Urocharis* has not been recognized by recent authors. Mayr (1931,

p. 668, footnote) gave reasons for uniting *Pristorhamphus* with *Melanocharis*. At that time he retained the genus *Neneba* for *striativentris* because of its somewhat different proportions and body build, but we now feel it is best to associate this species with its close relatives in the genus *Melanocharis*.

The five species here included in *Melanocharis* comprise a monophyletic group whose species intergrade in all variable characters. The total range of variation is not greater than that often included by recent workers within the limits of a single genus. While *Melanocharis* is in most respects primitive, some of the species are the only ones in the family with metallic plumage.

INCLUDED SPECIES: 1, *arfakiana*; 2, *nigra*; 3, *longicauda*; 4, *versteri*; 5, *striativentris*. All the species are restricted to New Guinea. Their ranges and subspecies are given by Mayr (1941). *Melanocharis arfakiana*, the plainest colored and perhaps most primitive species of the genus, is known from only two specimens collected almost at the opposite ends of New Guinea.

RHAMPHOCHARIS SALVADORI (CRASSIROSTRIS)

DIAGNOSIS: Closely related to *Melanocharis* but bill elongated and rather thin (culmen about 18 mm. as against 12 mm. in the larger species of *Melanocharis*). Male above olive green with a very slight gloss and below gray. Female brown spotted with white. Female very noticeably larger than male (wing in male 66 mm., in female 73 mm.). The larger size and different coloration of the female are remarkable. The male is not unlike some of the simpler species of *Melanocharis* in color. The single species of this genus is restricted to the mountains of New Guinea. *Rhamphocharis* and *Melanocharis* comprise a rather old and primitive section of the Dicaeidae, which is surprisingly absent from tropical north Australia.

SPECIES: 1, *crassirostris*.

ANAIMOS REICHENBACH (THORACICUS)

SYNONYM: *Charitociris* Oberholser (*percussus*). The name *Prionochilus* formerly used for this genus is preoccupied in the insects.

DIAGNOSIS: *Anaimos* has a relatively large tenth primary and serrated bill, as do the two preceding genera. It differs from *Melanocharis* and *Rhamphocharis* as follows: tail much shorter (about 30 mm., 50–60 per cent of wing); general size much smaller (total length about 80–90 mm. against 105–107 mm.); color pattern more varied, usually with some red and yellow in plumage; no white in tail; axillaries and under wing coverts snow white; females not larger than males; tongue more or less tubular.

Anaimos is very closely related to *Dicaeum*, the only constant difference being the noticeable tenth primary of *Anaimos*. The bill in the latter is heavier than in all but a few species of *Dicaeum*, and has a more or less characteristic shape. The crown patch and white malar stripe of *Anaimos* (except *olivaceus*) are rare in *Dicaeum*, but occur in a few species. So far as known the two genera are identical in nidification and habits.

Anaimos is, with the doubtful exception of *A. olivaceus*, a closely knit, natural group. The genus is in some respects primitive, as indicated by the large tenth primary and the heavy bill. In coloration, habits, and nidification it belongs with the more specialized flowerpeckers. The six species are confined to Malaysia and the Philippines and have apparently originated in this area.

The suggested interrelationships of the species of *Anaimos* and *Dicaeum* are indicated diagrammatically in figure 5.

SPECIES: 1. *A. olivaceus*. This Philippine species is the simplest of the genus in coloration and the only one without a crown patch and without any bright colors. It has neither a malar stripe nor a rump patch. There are two races, *olivaceus* and *parsoni*.

2. *A. maculatus*. This is the only species that is streaked ventrally. It resembles *olivaceus* to some extent in coloration but has a crown patch, which links it with the following species. It occurs in peninsular Siam, Malaya, Sumatra, Borneo, and some of the nearby smaller islands (four races).

3. *A. percussus*. This species is slaty

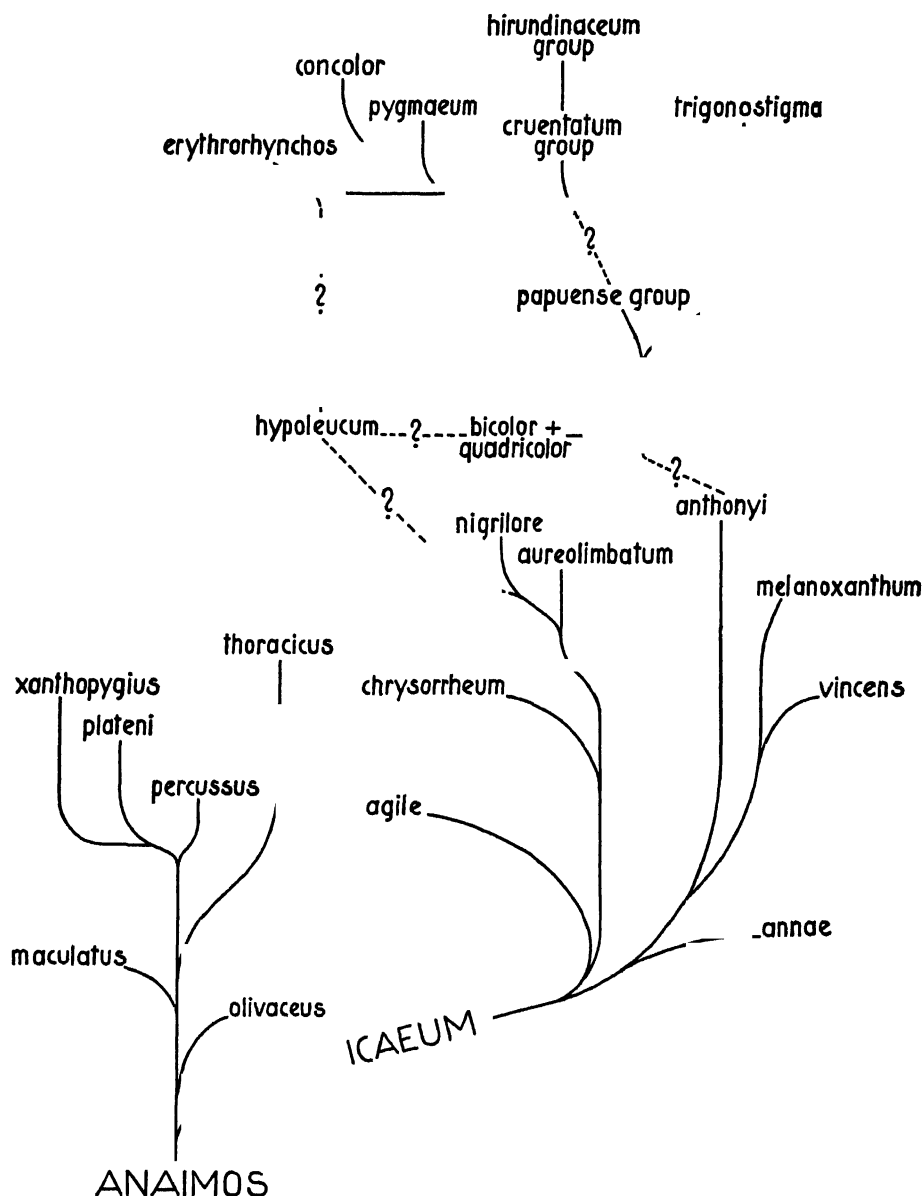


Fig. 5. Diagrammatic phylogeny of the species of *Anaimos* and *Dicaeum*.

blue above with a crimson crown patch and yellow below with a red pectoral spot. A white malar stripe is present. The races are: *ignicapillus* (Malaya, Sumatra, Rhio Archipelago, Billiton, Banka, North Natuna Islands, Borneo), *regulus* (Tana Massa, Batu Islands), and *percussus* (Java).

4. *A. plateni* (*johannae* auct.). Like *percussus* but with the rump yellow as in the following species, *xanthopygius*. Since *plateni*, which is endemic to Palawan, is intermediate between *percussus* and *xanthopygius*, which coexist on Borneo, it cannot be safely united with either species

as a race (Mayr, 1945, p. 115). We may assume that the widespread *percussus*, or its ancestor, spread to Palawan, giving rise to *plateni* which has reentered Borneo to produce the third species, *xanthopygius*. According to a recent letter from Hachisuka, the name *plateni* (Braunsch. Anzeiger, no. 52, 1888) antedates *johannae*, published in the same year.

5. *A. xanthopygius*. This species is much like *plateni* but lacks the white malar stripes. It is found on Borneo and the North Natuna Islands.

6. *A. thoracicus*. A rather rare, monotypic species of Malaya, Borneo, and Billiton. The color pattern is distinctive: head and breast black, mid-breast and crown crimson, rump yellow, back citrine olive. This pattern suggests remote relationship with *Dicaeum trigonostigma* or *D. quadricolor*.

DICAEUM CUVIER (CRUENTATUM)

SYNONYMS: *Acmonorhynchus* Oates (*vincens*); *Chilociris* Oberholser (*aeruginosus*, a race of *agile*); *Chromatociris* Oberholser (*quadricolor*); *Cryptociris* Oberholser (*obsoletus*, a race of *agile*); *Pachyglossa* Blyth (*melanozantha*); *Piprisoma* Blyth (*agile*); *Polisornis* McGregor (*anthonyi*).

Polisornis was proposed as a subgenus. McGregor also proposed a subgenus *Bournsia* with the same type (*aeruginosus*) as the earlier *Chilociris* of Oberholser.

DIAGNOSIS: Similar to *Anaimos* but tenth primary vestigial (in *D. melanozanthum*, the only species of *Dicaeum* with a visible tenth primary, this primary is short and very narrow, only about 10 mm. long and 1 mm. wide, compared with about 13 mm. by 2.5 mm. in *Anaimos*); crown patch and malar stripe usually lacking; bill often thinner than in *Anaimos* with the lower mandible less upturned. In specimens preserved in fluid the tarsus is seen to be scutellate in front (probably the same is true of *Anaimos*) and hence more "primitive" than in the other genera (*Pardalotus*?) in which it is virtually booted.

The various genera that we synonymize were based primarily on differences in the thickness and shape of the bill, but these are not of a nature to indicate natural groups of

species as we have pointed out above. Mayr (1945, p. 114) has shown in more detail the drawbacks of further subdividing the genus *Dicaeum*.

As it has long been known that the tenth primary is vestigial in many flowerpeckers, it is surprising that Oberholser (1923) confused the ninth primary with the tenth in the species he studied (*quadricolor*, *vincens*, some races of *agile*) and stated that the tenth primary is not reduced in these species. Actually it is reduced to the vanishing point.

Although some of the species of *Dicaeum* are easily arranged into species groups, the natural arrangement of all species of the genus is difficult. As already noted, the bill tends to become thinner in the more advanced species, but this trend has been reversed several times. The coloration of most species of the presumably more primitive *Anaimos* is bright and varied, and hence the more simply colored species of *Dicaeum* are not necessarily primitive. *D. concolor*, *D. erythrorhynchus*, and *D. tristrami* probably owe their plain colors to secondary simplification. All three are closely linked with bright-colored species. Certain groups of forms that still are geographical representatives (superspecies) show great variation in shape of bill and in coloration, e.g., the *papuense-retrocinctum* group, the *bicolor-quadricolor* group, and the *erythrothorax* group (including *tristrami*). Some of the more unusual color patterns in *Dicaeum*, such as those of *chrysorrheum*, *agile*, *anthonyi*, and *annae*, suggest that *Dicaeum* may not be monophyletic in the narrowest sense of the term, but that various branches may have developed from different species of *Anaimos* or *Anaimos*-like ancestors. Thus *Dicaeum annae* resembles *Anaimos olivaceus* in some respects, and the streaked *D. chrysorrheum* (and perhaps *agile*) may be directly related to the streaked *A. maculatus*. Some of these resemblances are doubtless deceptive, and we cannot suggest any further subdivision of the genus that would not obscure rather than elucidate relationships. The only question is whether it is profitable to separate *Anaimos* and *Dicaeum*. We do so only tentatively.

The phylogeny of *Dicaeum* suggested in figure 5 and explained in the following account of the species attempts to reconcile the above difficulties, but will doubtless be improved as further knowledge of life histories, eggs, and anatomy accumulates. The first eight species listed in *Dicaeum* are the most primitive and most like *Anaimos* in the shape of the bill and in coloration.

SPECIES: 1. *D. annae*. This peculiar species occurs in the Lesser Sunda Islands, the nominate race on Flores and the race *sumbawensis* on Sumbawa. Records from other islands seem to be due to early confusion with *D. agile*. In *D. annae* the males have a half-concealed patch of bright yellow feathers on the lower back. This feature is unique in the family but possibly homologous with the yellow rumps or lower backs of such species as *Dicaeum quadricolor* or *Anaimos olivaceus*. It equally resembles *Dicaeum agile*, which also occurs in the Lesser Sundas, and since both of these species lack the tenth primary the relation may be closer than with *olivaceus*.

2. *D. agile*. Many of the races of this widespread species (or superspecies) are rare in collections. It is a dull species, grayish above and whitish below, usually more or less streaked. The bill is thick, short, and blunt. The eggs are spotted, and the nest, while in general like those of the genus, is said to be especially finely woven, so as to regain its shape even after being rolled up or crushed. The species must be considered rather aberrant but not necessarily primitive. Two forms of the *agile* group have been thought to occur together in the Malay Peninsula, but this seems doubtful (Deignan, 1945, p. 550). The heavily streaked Philippine form (*aeruginosum*) is linked with the others by *affine* of Palawan, while the unstreaked *obsoletum* of Timor is linked with the striated forms by *tinctum* of the nearby islands. We believe it will prove correct to unite all the forms listed below as races of *agile*. Oberholser (1923) divided them among three genera and five species, with two other species (*vincens*, *quadricolor*) sandwiched in between.

Most races of *agile* have white spots on the inner vanes of the outer tail-feathers (absent in *aeruginosum*). This suggests relationships to *vincens* and *melanozanthum* the only other species of *Dicaeum* with such marks.

The races of *agile* are: *zeylonense* (Ceylon); *agile* (India); *modestum* (? eastern India, Burma, Malay Peninsula; see Deignan, *loc. cit.*); *pallascens* (Siam, Indo-China); *atjehense* (Sumatra); *finschii* (Java); *tinctum* (Sumba, Flores, Alor); *obsoletum* (Timor); *bungureense* (North Natuna Islands); *everetti* (Borneo, Labuan); *affine* (Palawan); *aeruginosum* (Philippine Islands).

The name *atjehense* was proposed by Delacour (1946, p. 4) for *Piprisoma sumatranus* Chasen, preoccupied in *Dicaeum*. The older records of this species from Sumbawa are based on a mistake of Hartert's in identifying immatures of *D. annae* as the present species. We have found no definite records for Sumbawa.

3. *D. chrysorrheum*. This species contains three races which range from eastern and northern India through the Indo-Chinese countries and Malaysia. This and *agile* (some races) are the only species of *Dicaeum* having streaked underparts. *D. chrysorrheum* has a thin bill, very unlike that of *agile*. The yellow under tail coverts of *chrysorrheum* apparently link it with the following group of yellow-bellied species (nos. 4-8). The bright olive upperparts of *chrysorrheum* are also partly duplicated in *aureolimbatus* and *nigrilore* of the group just mentioned. We thus tentatively place *chrysorrheum* as a link between the streaked *agile* and the species with partly yellow underparts but without conviction that the similarity to *agile* actually indicates close relationship.

4. *D. anthonyi*. The few known specimens of this species, which McGregor described from the moss forests of the northern Luzon mountains, were in the destroyed collection of the Manila Bureau of Science (for a colored plate see McGregor, 1914). It is the only species of *Dicaeum* with a yellow crown patch (male only) like that usual in *Anaimos*. The back is glossy black in the male, olive green in the female.

The throat is white; the breast and abdomen are yellow. This coloration plus the heavy bill, mountain range, and apparent rarity of *anthonyi* suggest that it is primitive. McGregor (1927, p. 522) clearly states that *anthonyi* has the tenth primary vestigial, so we must place it in *Dicaeum*. In color pattern *anthonyi* is rather similar to the four species that follow (nos. 5-8), all of which perhaps have a relict distribution.

5. *D. melanozanthum*. This Himalayan species is the largest of the genus and, as are many mountain species, is rather long winged. It is the only *Dicaeum* in which the tenth primary is visible, though very small. Like *anthonyi* it is bluish black above and yellow below with white throat and breast, but it lacks a crown patch, and the black has encroached on the sides of the breast. There are white spots on the outer tail feathers. The bill is broad and short. It was formerly separated in the genus *Pachyglossa*.

6. *D. vincens*. This species resembles *D. melanozanthum* in so many details of coloration as to leave little doubt they are related, as P. L. Sclater (1874) pointed out long ago when figuring them together in the Ibis. *D. vincens* is found in the lowlands and foothills of Ceylon. The tail feathers have large white spots near their tips that are undoubtedly homologous with those of *melanozanthum*.

7. *D. aureolimbatus*. This Celebes species resembles the three preceding ones, but the white of the breast extends back with yellow restricted to the sides. Above only the wings, tail, and sides of the head are blackish; the rest is yellowish olive. The bill is short and thick. A race occurs on Sangir.

8. *D. nigrilore*. A Mindanao species rather rare in collections (colored plate: Novitates Zool., 1920, vol. 26, pl. 6). Very similar to *aureolimbatus* but the back is brownish, only the crown and flight feathers olive. The bill is thin and decurved, but the coloration and distribution leave little doubt that *nigrilore* is a close relative of *aureolimbatus*. It helps link the heavy-billed species with those with thin bills. The species was apparently redescribed by Hachisuka (1941) as *Di-*

caelum isag. The original description does not mention a single character not applicable to *nigrilore*, and the colored plate looks like *nigrilore*.

9. *D. hypoleucum*. This Philippine species contains three races: *hypoleucum* of Basilan and Mindanao, *pontifex* of the Samar-Leyte group, and *obscurum* of Luzon. Although there is a considerable variation in color of plumage and soft parts from north to south, *pontifex* is intermediate between *hypoleucum* and *obscurum*, so that it seems justifiable to unite the three forms in a single species (Mayr, 1945, p. 115). Better material may show that Tweeddale's race *mindanense* is separable from typical *hypoleucum*. Mayr (1946) proposed the name *pontifex* as a substitute for *Dicaeum everetti* Tweeddale, which is preoccupied by *Prionochilus everetti* Sharpe, once the latter is transferred to *Dicaeum* as a race of *D. agile*. The rather attenuated bill and to some extent the coloration of *hypoleucum* resemble *nigrilore*, although the relationship may not be very close.

10, 11. *Dicaeum bicolor*, *D. quadricolor* (superspecies). Males of *D. bicolor* are bluish black above and gray below with a whitish mid-ventral area. Two races occur in the Philippines. On Cebu it is replaced by the little known *quadricolor* (colored plate: Proc. Zool. Soc. London, 1877, pl. 77, fig. 2), similar but with the upper back scarlet and the lower back ochraceous green. The two species agree in all structural details and seem to be geographical representatives despite these striking differences in coloration. Similar variation occurs in the following superspecies (*papuense*). Females and young of both species are dull and scarcely separable.

Dicaeum bicolor is like *D. h. hypoleucum* in color and perhaps related, but the bill is heavy as in *anthonyi* or *melanozanthum* and (together with *papuense*) it links these rather primitive, heavy-billed species with the more widespread and apparently advanced, thin-billed species that follow. Both *bicolor* and *hypoleucum* resemble some species of *Melanocharis* in their style of coloration.

12, 13. *D. papuense*, *D. retrocinctum* (superspecies). The ranges of the three

forms in this Philippine superspecies are as follows: *D. retrocinctum*, Mindoro; *D. papuense haematostictum*, Guimaras, Negros, Panay; *D. p. papuense*, most of the other Philippines from Luzon to Mindanao and Basilan. *D. p. papuense* is similar to *D. bicolor bicolor*, but the bill is thinner and longer, the back is duller black, and the mid-ventral area is crimson, not white. *D. papuense haematostictum* is similar, but the back is glossier and the ventral red area is partly encircled with black at the breast. In *D. retrocinctum* the bill is much thinner and the entire breast is black, meeting the black of the top of the head and neck. There is a patch of lanceolate red feathers on the throat and also a transverse crimson patch of red in the scapular region. Thus, a red dorsal patch is a variable character in this superspecies, as it is in *D. bicolor-quadricolor*.

This superspecies provides another instance of the small taxonomic value of variation in the bill in flowerpeckers. It is the only brightly colored species of *Dicaeum* in which females have acquired the male type of coloration. *Dicaeum flaviventer* Meyer was probably based on a specimen of *D. papuense* discolored by alcohol (Mayr, 1945).

14. *D. trigonostigma*. This species occurs in the Philippines, Malaysia, and the southern Indo-Chinese countries. There are eight races in the Philippines alone and about an equal number in the rest of the range. This is a thin-billed species with a red or orange patch on the upper back and often with a yellow rump patch, which sometimes is joined with the back patch. Throat and breast are grayish and the rest of the underparts bright yellow. Females are dull greenish. This is one of the most specialized species of the genus; it is probably of Philippine origin for the color pattern suggests *D. retrocinctum*.

15. *D. erythrorhynchos*. This dull-colored, thin-billed, tiny species is found in peninsular India, with a race on Ceylon. The dull coloration is probably secondary. It is a close relative of *concolor* and so similar to it that occasional specimens may not be identifiable.

16. *D. concolor*. This is another dull-

colored, thin-billed species similar to *erythrorhynchos*, though they occur together in some parts of India. It is much more widespread, with the following races: *concolor* (southern India), ? *subflavum* (central India), *olivaceum* (Himalayas to Yunnan and Kwangtung, south through the Indo-Chinese countries), ? *sinense* (Szechwan), *uchidai* (Formosa), *virescens* (Andaman Islands), *minullum* (Hainan), *borneanum* (Malaya, Sumatra, Borneo, North Natuna Islands), *solicitans* (Java, Bali).

17. *D. pygmaeum*. This Philippine and Palawan species may be a representative of *concolor*, a species which it resembles in its dull coloration, thin bill, whitish spot before the eye, and small size. On the other hand, males of *pygmaeum* have a slight bluish gloss on the wings, a whitish mid-ventral area, and a yellowish rump, suggesting the following *cruentatum* group of species, also lacking in the Philippines unless represented by *pygmaeum*. Thus the latter seems to link *concolor* loosely with the *cruentatum* group.

THE *cruentatum* SPECIES GROUP

The ranges of the 13 species comprising this species group (species 18–30, below) are mapped in figure 6, and their supposed phylogeny is shown in figure 8.

Before the evolution of this group is discussed, the species will be listed and briefly described.

18. *D. nehrkorni*. In the male of this Celebes species, the crown, forehead, rump, and a small spot on the mid-breast are crimson, the back and wings glossy bluish black, the breast and sides gray, the belly and under tail coverts white with a blackish area medially. The female is similar but duller, with no crimson on the breast and only a suggestion of it on the head; the rump is red as in the male.

19. *D. vulneratum*. This monotypic species is found on Amboina, Seran, and Goram in the southeastern Moluccas. Like *nehrkorni* it is very grayish below, lighter in the female, with a red pectoral spot in the male. This red mark is much larger in *vulneratum* than in *nehrkorni*. Dorsally both sexes of *vulneratum* resemble the female of *nehr-*

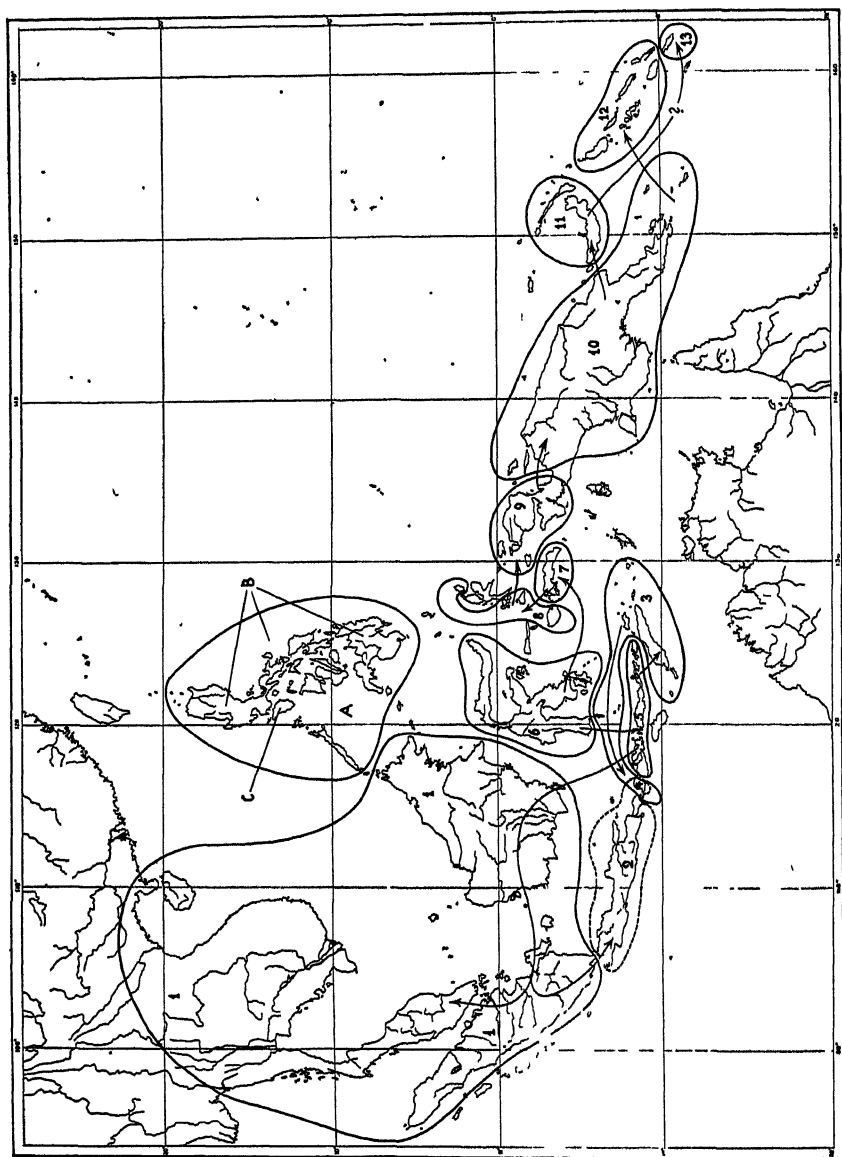


Fig. 6. Distribution and route of colonization of the *Dicaeum cruentatum* group; distribution of *Dicaeum pigmaeum* *D. papuense*, and *D. retroctinctum*. 1, *cruentatum*; 2, *trochileum*; 3, *maugei*; 4, Overlap of *trochileum* and *maugei* on Lombok. 5, *igniferum*. 6, *nehrkorni*. 7, *vulneratum*. 8, *erythrohorax*. 9, *pectorale*. 10, *geelinkianum*. 11, *extremum*. 12, *aeneum*. 13, *tristrami*. A, *pigmaeum*. B, *papuense*. C, *retroctinctum*.

korni: rump red; crown grayish like the back (not red!); no dark blue gloss as in the male of *nehrkorni*. Male without black ventral stripe.

20. *D. erythrothorax*. This species resembles *vulneratum*, but flanks and belly are washed with yellowish olive. The rump is not red, but the back is washed with olivaceous which becomes yellowish on the rump in the male (probably the final stage in the loss of the red rump). The male has a large red breast patch. The race *erythrothorax* with white throat occurs on Buru in the southern Moluccas, and *schistaceiceps* with gray throat on Obi, Batjan, and Morotai in the northern Moluccas. Its apparent absence on Halmahera is surprising.

The characters of the two Moluccan species leave little doubt that *vulneratum* is closest to *nehrkorni*, although the Buru race of *erythrothorax* is now more or less intermediate geographically. Probably *erythrothorax* (*schistaceiceps*) was originally limited to the northern Moluccas where it was an offshoot of *vulneratum*. Recently it spread south to Buru where *vulneratum* for some reason was absent.

21. *D. pectorale*. This species is found on the islands of Misol, Salawati, Batanta, and Waigeu west of New Guinea and on the coasts of western New Guinea. These islands are close to the northern Moluccas, and *pectorale* is evidently a descendant of *erythrothorax*. It is similar to *erythrothorax* but more olivaceous, less grayish throughout, even becoming greenish on the crown and back. There is no trace of a red rump patch. It is a smaller species.

22. *D. geelvinkianum*. The range is New Guinea (except the part occupied by *pectorale*), some of the nearby islands, and the Louisiade Archipelago. In the male the upperparts are almost as in *nehrkorni*, but glossed with purplish blue. Below it is very similar to *pectorale*. The female is like the male but duller with the crown and rump reddish. The two races of the Louisiades (*nitidum* and *rosseli*) are somewhat different: back glossed with greenish; tone of underparts ochraceous; crown duller, almost maroon. These are differ-

ences of degree, and we do not think it necessary to recognize *nitidum* as a species.

In this species the rump is red as is usual in the *cruentatum* group and not gray as in *pectorale* and *erythrothorax* from which *geelvinkianum* was presumably derived.

23. *D. eximium*. This species is found on the larger islands (New Britain, New Hanover, New Ireland) in the Bismarck Archipelago. The male is white below with a red breast spot bordered with grayish brown which extends back more or less on the sides and mid-ventral area. Above it is dull brownish olive with red rump, a maroon wash on the crown, and a faint blue gloss on the tail. The female is similar but entirely whitish below except along the flanks and sides. It is thus quite different in appearance from the neighboring species. Eye-ring, loreal and malar stripes are white. In the latter character it resembles *Anaimos*.

24. *D. aeneum*. In this Solomon Islands species there is a return to the brighter coloration usual in this group. The male is remarkably similar to *D. e. erythrothorax*, but the gray upperparts are more brightly glossed with greenish, without noticeable yellow wash even on the rump. There are other minor differences. The female is similar to that of *erythrothorax*.

25. *D. tristrami*. This very aberrant species is found on San Cristobal in the Solomons (where *aeneum* is lacking). It is entirely without lipochromes: white below, washed with gray on the sides, brownish across the chest. The back and sides of the head are brown, more or less mottled with whitish; darker and slightly glossy on wings, tail, and malar stripes. The sexes are alike. The bill is unusually heavy and large. *D. tristrami* carries much further tendencies apparent in the rather dull *eximium* of the Bismarck Archipelago. It is possible that *tristrami* was derived from *eximium*, while *aeneum* descended more recently and directly from *geelvinkianum* (probably *nitidum*). On the other hand, it may be merely another example of the parallelism that is common in the species group (e.g., the similarity of *aeneum* to *erythrothorax*).

All of the species of the *cruentatum* group just listed, with the possible exception of *nehrkorni*, may be considered members of a single superspecies, and all (except *tristrami*) are obviously closely related geographical representatives, though many are so distinct we think it better to consider them species. We now return to a group of more specialized species which are linked through *nehrkorni* to those listed above.

26. *D. igniferum*. The upperparts of the male are similar to those of *nehrkorni*, but the back is washed with red. Wings and tail are black glossed with dark purplish blue. The throat is white, the breast red. The sides of the head are black, and this extends around as a border below the red breast and then back as an indefinite line separating the white abdomen. The pattern below is thus similar to the geographically distant *etimium*. The female is whitish below, duller on the breast; the back is similar to that of the male but duller. This species occurs in the north central part of the Lesser Sunda Islands, the nominate race on Sumbawa and Flores, and *cretum* on the islets Pantar and Alor.

27. *D. maugei*. The underparts of the male in this species are almost the same as in its close relative *igniferum*. Above, only the rump is red; the rest of the plumage is black glossed with dark purplish blue as are the wings and tail of *igniferum*. The females of the two species are similar ventrally, while dorsally red occurs only on the rump in *maugei*.

The races of *maugei* are: *maugei* (Timor, Samau, Savu); *salvadorii* (Moa, Babar); *romae* (Roma, Damar); *splendidum* (Djampoa and Saleyer, between Celebes and the Lesser Sundas); *neglectum* (Lombok); and *mariae* (islet of Penida, south of Bali). The validity of Neumann's race *mariae* is doubtful, as Meise intimates (1941). The ranges of *igniferum* and *maugei* suggest that the former evolved in the western and the latter in the eastern part of the Lesser Sunda group. Recently *maugei*, which has been able to colonize small islands, extended its range to more or less encircle that of *igniferum* but without overlapping. On Lombok, however, it has

overlapped with the less closely related *trochileum*.

Rensch (1931, p. 616) mentions finding *trochileum* in the lowlands of Lombok up to 200 meters. *D. maugei neglectum* occurs in the lowlands also but ranges up to 2000 meters and is much more common. We lack material of the Lombok race of *trochileum* and cannot judge which of these subspecies is more differentiated (and hence perhaps older). Other evidence suggests that *trochileum* is the more recent arrival on Lombok. *D. maugei* has colonized the small island of Penida, but not adjacent Bali, suggesting that the presence of *trochileum* may have excluded it on Bali though not on Lombok.

28. *D. cruentatum*. Whereas *D. maugei* appears to be a relative of *igniferum* in which the red of the upperparts (except the rump) has been lost, in *cruentatum* the red has been intensified so that the entire crown, back, and rump are scarlet. The wings and tail are deep bluish black, the sides of the head and breast duller black, and a broad mid-ventral stripe is white. The female is duller, with only the rump red. The tone of the plumage is soft, suggesting *nehrkorni*, which some authors have considered the closest relative of *cruentatum*. It is possible, therefore, that the red back was independently acquired in *igniferum* and *cruentatum*, although *igniferum* is intermediate as regards the presence of red on the back.

The races of *cruentatum* are: *nigri-mentum* (Borneo); *niasense* (Nias); *batuense* (Batu Islands); *sumatranum* (Sumatra); *ignitum* (Malay Peninsula, most of Burma); *siamense* (Siam, Indo-China); *erythronotum* (*coccineum* auct.; see Doigman, 1943; southern China); *hainanum* (Hainan); *cruentatum* (eastern India, northern Chin Hills).

29. *D. trochileum* (*flammeum* auct.). The entire upperparts, head, throat, and breast are light crimson in the male. The underparts are uniform gray; the wings and tail bluish black similar to *cruentatum*. The female is light grayish with a red rump. This is a very specialized species—the only one of the genus with the head entirely red. For this reason we place it after *cruentatum*,

although on geographical evidence, if these species were derived from *igniferum*, presumably this stock reached Java before Sumatra or Borneo. As noted above, an alternative theory is that *cruentatum* and later *trochileum* were independently derived from *nehrkorni*, the dispersal then being from Celebes to Borneo, Sumatra, and Java.

Dicaeum trochileum occurs on Java and Bali, with a race *stresemanni* on Lombok, where it overlaps with *D. maugei neglectum*. This is the only overlap of range in the *cruentatum* species group. *D. trochileum* is so distinct there could be little doubt of its specific status, even if this overlap did not exist.

EVOLUTION OF THE *cruentatum* SPECIES GROUP

It has already been pointed out that *pygmaeum* may be a plainly colored member of this group or it may represent the still more dully marked *D. concolor* in the Philippines. It thus serves to link the *cruentatum* group with *concolor*. The latter, along with *erythrorhynchos*, is perhaps an Indian equivalent or representative of some of the more brightly colored island species. The *cruentatum* group is basically one with a bright and varied color pattern. A suitable type of ancestral stock among existing species is provided to some extent by the *papuense-retrocinctum* superspecies of the Philippines which supplies a transition from the heavier-billed *Anaimos* type of species to the more advanced ones, although the relationship is not close.

Turning to the interrelationships of the members of the *cruentatum* group, the four species of the Sunda Islands (*cruentatum*, *trochileum*, *igniferum*, *maugei*) are more differentiated than the others, and it is here that the only instance of overlapping range in the group occurs (Lombok). This suggests that these species are older than the Moluccan-Papuan ones. On the other hand, the rather specialized characters of the Sunda species (such as the red back) do not make them likely immediate ancestors of the somewhat simpler Moluccan and Papuan species. *D. nehr-*

korni of Celebes does furnish an excellent transition from the Sunda to the Moluccan species, as it is obviously related to both. Perhaps the Sunda species are older than the Moluccan ones, but *nehrkorni*, though a member of the Sunda group, never acquired the red back and other specialized characters of that group. More recently, we may assume, *nehrkorni* stock radiated eastward, giving rise to the series of allopatric Moluccan and Papuan species. Another possibility is that the Moluccan and Papuan species are as old as, or older than, the Sunda ones, but that the former have been kept more or less similar by occasional stragglers from island to island with resultant gene exchange. Whichever of these hypotheses is favored, *nehrkorni* may be taken as a central point in the *cruentatum* species group (figs. 6, 8).

Dicaeum maugei is a relative of the red-backed *igniferum* in which the back is black. Its resemblance to the type of pattern of the Moluccan-Papuan species is apparently parallelism.

CHARACTER GEOGRAPHY IN THE *cruentatum* SPECIES GROUP

In the brightly colored species of *Dicaeum*, the color pattern often changes rather abruptly in closely related forms. This is true both of the *cruentatum* species group and of others already mentioned. Perhaps this means that some of these color characters are controlled by a few or single genetic factors. In several instances, however, it is obvious that red marks are only partially or dully indicated, suggesting a more complex genetic basis. This type of abrupt variation is favored by the insular distribution of many of these forms. The bright varied coloration of the ancestral *Anaimos* demonstrates that such patterns were already present when the species of *Dicaeum*, such as the *cruentatum* group, evolved. Some of the plainer species of *Dicaeum* are not primitive in this respect, but have lost the bright coloration of their relatives secondarily. This is obviously true of *tristrami* and probably of *pygmaeum* and *erythrorhynchos*.

In the above list of species some use was made of character analysis, as in point-

ing out the closer relationship of *vulneratum* than of *erythrothorax* to *nehrkorni*. The geographical variation in color characters is more fully analyzed here (table 1).

RUMP: In most species of the *cruentatum* group the rump is red (in both sexes), but four species *erythrothorax*, *pectorale*, *aeneum* and *tristrami*, are exceptions. The rump is still yellowish in *erythrothorax*, suggesting recent loss. In *pectorale*, which seems to have been derived from it, the rump is no longer yellow. In *aeneum* of the Solomon Islands the loss of the red rump was probably independent of that in *pectorale*, since in the intervening area two red-rumped species, *geelvinkianum* and *eximium*, occur. The fact that the rump is not red in *tristrami* might be interpreted to mean that it was derived from the other Solomons species, *aeneum*, but other features of the coloration indicate that *tristrami* may have been derived from the Bismarck Archipelago (*eximium*) and *aeneum* from New Guinea or the Louisiades (*geelvinkianum*).

CROWN AND BACK: A red crown is less

breast is characteristic of all the closely related species extending from Celebes (*nehrkorni*) eastward through the Moluccas and the New Guinea region to the Solomon Islands, except for the aberrant *tristrami*. This red breast spot may be a transmutation of the red abdominal stripe found in the superspecies *D. papuense*. This assumption is strengthened by the fact that the red spot is continued in *nehrkorni* and *eximium* by a dark abdominal stripe. A red spot on the lower throat is also found in some species of the Malaysian branch of the *cruentatum* group (*igniferum-maugei*), but is lost in the more specialized species *cruentatum* and *trochileum*. The red throat of *trochileum* seems not to be homologous with the red breast spot of the other species, but rather due to the encroachment of the red of the crown around the sides of the head onto the throat.

The accompanying chart (table 1) summarizes the variation of the more important color characters in the group.

TABLE 1
CHARACTER VARIATION IN *Dicaeum nehrkorni* AND RELATIVES

Males	Belly Stripe	Red Breast Patch	Crown	Back	Rump
<i>nehrkorni</i>	Black	Small	Red	Black, blue gloss	Red
<i>vulneratum</i>	—	Medium	Gray	Gray	Red
<i>erythrothorax</i>	—	Large	Gray	Olive	Olive
<i>pectorale</i>	—	Medium	Olive	Olive	Olive
<i>geelvinkianum</i>	—	Small	Red	Blue gloss	Red
<i>nitidum</i>	—	Medium	Red	Green gloss	Red
<i>aeneum</i>	—	Large	Gray	Gray, green gloss	Gray
<i>eximium</i>	Brown	Medium	Reddish brown	Brown	Red
<i>tristrami</i>	—	—	Mottled brown	Brown	Brown

characteristic of the *cruentatum* group than a red rump, occurring in fewer species and being absent in the female when present in the male. It occurs in *igniferum*, *cruentatum*, and *trochileum*, and in these the back is also more or less red. They are undoubtedly closely allied. The crown is also red in males of *nehrkorni*. The red crown has been lost in the two Moluccan species and in *pectorale* of the western New Guinea Islands but reappears in *geelvinkianum* and *eximium*, though reduced in the latter. It is entirely lost again in the two Solomon Islands species.

BREAST AND THORAX: A red spot on the

THE SUPERSPECIES *Dicaeum hirundinaceum*

The species of this superspecies are very similar to some of the species of the *cruentatum* group, and there can be no question of a very close relationship. However, both groups occur together on Celebes and in most of the Greater and Lesser Sunda Islands, although they are usually altitudinally separated. The greatest similarity exists between the species *maugei* and *sanguinolentum* which represent the two groups on the Lesser Sunda Islands, and scarcely two authors have agreed as to how to associate these species with the species of the

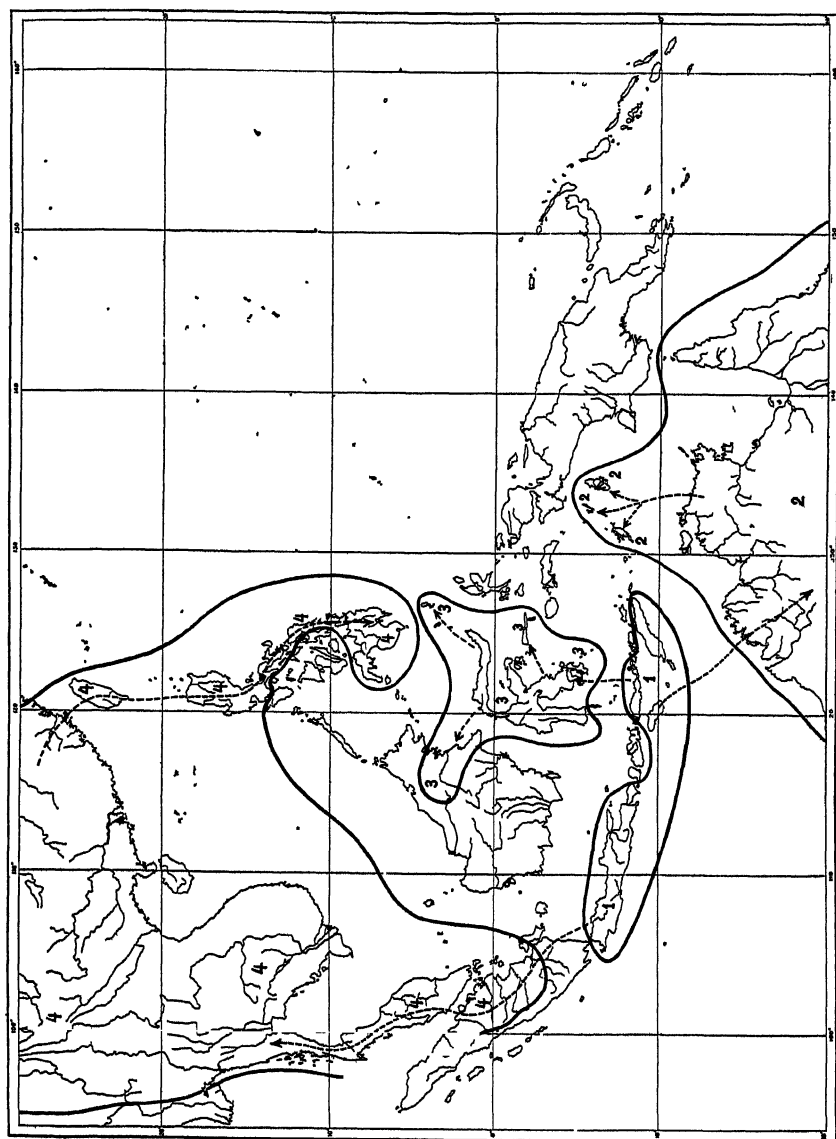


Fig. 7. Distribution and route of colonization of the superspecies *Draeum hiruudinaceum*. 1. *sanguinolentum*. 2. *hiruudinaceum*. 3. *celebicum*. 4. *ignipectus*.

neighboring islands. A close study suggests that *maugei* or the form ancestral to *maugei* gave rise to the *hirundinaceum* group, but the exact stages in which this speciation occurred were subsequently obscured by reinvasions and range changes. The most probable hypothesis is that the *hirundinaceum* group originated by the colonization of the western Lesser Sunda Islands (giving rise to *sanguinolentum*) by a *maugei*-like stock coming from the Timor group. Subsequent range expansions of *sanguinolentum* and *celebicum* and of descendants of these forms has led to the present distribution. The *cruentatum* and *hirundinaceum* groups still replace each other geographically on most smaller islands, especially in the area from Celebes and the Lesser Sundas eastward. The *hirundinaceum* group is considered to be the younger because of the lesser degree of differentiation among its members and, in part, because of its distribution (fig. 7).

The only constant character separating the *hirundinaceum* and *cruentatum* groups is the fact that the rump is never red in males of the former group. It is sometimes red in the female, especially in *sanguinolentum* which is nearest to the *cruentatum* group. Even this is not a very satisfactory distinction, as the red rump has been lost in a few Moluccan and Papuan species of the *cruentatum* group. The upperparts in males of *hirundinaceum* and allies are in general more glossy than in those of the other group, and there are other minor points which help in separating them. Here, too, the difference is least in the Lesser Sunda forms of *maugei* and *sanguinolentum*.

It is difficult to divide the *hirundinaceum* group satisfactorily into species. Deignan (1945, p. 548) has recently listed them all as races of *hirundinaceum*, although he confusingly uses the term superspecies. Since, in several other instances, forms of *Dicaeum* as similar as *sanguinolentum*, *hirundinaceum*, and *celebicum* occur together as good species, we prefer to recognize the following four groups of forms as species:

30. *D. sanguinolentum*. There are four races, as follows: *sanguinolentum* (Java and

Bali), *rhodopygiale* (Flores), *wilhelminae* (Sumba), *hanieli* (Timor). Robinson and Kloss described a race *ablutum* from eastern Java and Bali, of which the most striking character was the supposed absence of the red rump in the female. Others (Chasen, 1940, p. 265) surmised that an immature male may have been mistakenly considered a female. This seems to be the case, as the only female from the range of *ablutum* examined by us (Bali, Stresemann collector) has the rump as red as in any race of *sanguinolentum*. Chasen thought *ablutum* valid on the basis of other characters, but our material, which includes four males from Bali, makes this appear doubtful.

The upperparts of the male are glossed with dark bluish purple varying slightly in tone among the races. The underparts are buffy white with a large red pectoral spot in *s. sanguinolentum*. *D. s. rhodopygiale* is similar, but the breast spot is paler. In *hanieli* the red area is smaller, and the underparts are whiter. In all these races there is a small indistinct blackish area posterior to the red breast. In *wilhelminae*, the breast spot is large, extending to the chin, and the mid-belly and sides are extensively blackish. The females of all races are grayish or buffy white below and olive gray above with a red rump. The bill is small in *sanguinolentum* and *rhodopygiale*, medium in *hanieli*, and stout in *wilhelminae*. The Flores race is nearer to the Javan one in all particulars than is that of Sumba. This is a mountain species.

31. *D. hirundinaceum*. This we consider a separate species because the under tail coverts are red or pink in both sexes in all four races. The rump is no longer red in the female of *h. hirundinaceum* of Australia, but is still tinged with red in the three other races: *ignicolle* (Aru Islands), *keiense* (Kei Islands), *fulgidum* (Tenimber Islands). The back in the male is similar to that of *sanguinolentum*, but the gloss is a little more bluish. Ventrally there is a great resemblance to *D. s. wilhelminae* of Sumba, from which *hirundinaceum* was apparently derived, though the breast is redder, less orange. The bill is quite heavy as in *wilhelminae*. In this instance there is little doubt that Australia was

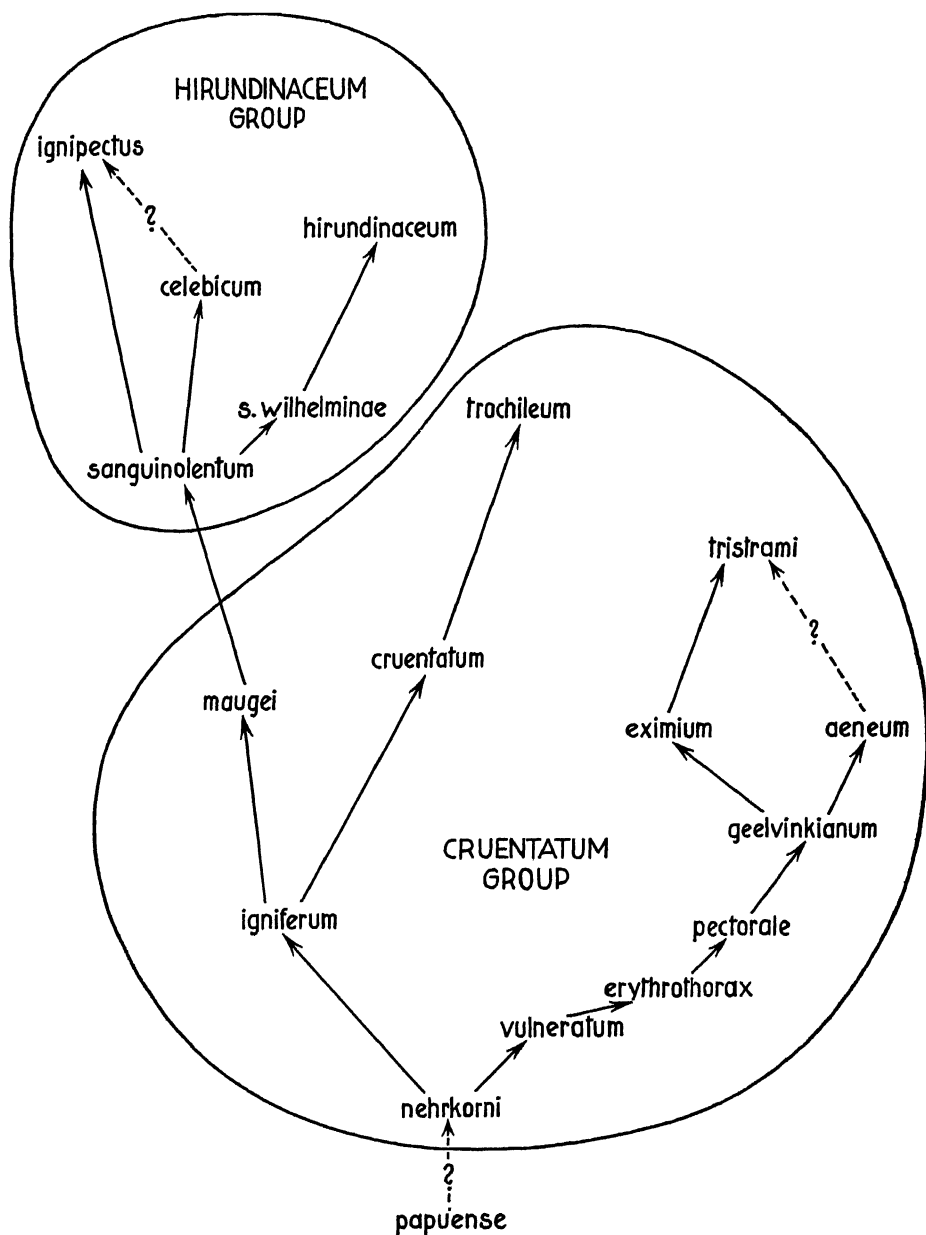


Fig. 8. Diagrammatic phylogeny of the *cruentatum* and *hirundinaceum* groups.

colonized from Sumba, not from Timor which is more usual (Mayr, 1944).

Dicaeum h. hirundinaceum is the common Mistletoe Bird of Australia, generally and commonly distributed, and, as would be expected, is mainly not a mountain bird. Mathews has described a number of Australian races now in need of scouting, of which perhaps *yorki* of northern Australia is valid.

32. *D. celebicum*. This is kept specifically distinct from *sanguinolentum* and *hirundinaceum* because the rump is not red in the female and the under tail coverts are never red. Although the back is dark purple in the Celebes race, some of the others on islands near Celebes are much bluer, almost like *monticola* of Borneo. As the latter form does not differ in any significant respect, we keep it in *celebicum*. Most of the races occur both in mountains and lowland, but *monticola* only in mountains.

Dicaeum celebicum is closely related to *sanguinolentum*. The distance between the races of the former occurring in the Lesser Sundas and *celebicum* is not great. *D. celebicum kuhni* of the Tukang Besi Islands is very much like *D. sanguinolentum wilhelminae* in color (except for the red rump of the female in the latter), but the shape of the bill is more as in *D. s. rhodopygale* of Flores. The females of most races of *celebicum* are glossier than in the allied species, while the males tend to be darker and suffused with black or gray ventrally.

The races of *celebicum* are: *kuhni* (Tukang Besi Islands), *sulaense* (Sula Islands), *celebicum* (Celebes, Buton, Muna), *sanghirense* (Sangir Islands), *talautense* (Talaut Islands), and *monticola* (Mts. Kinabalu and Dulit, Borneo).

33. *D. ignipectus*. The races and distribution are as follows: *beccarii* (northern Sumatra); *cambodianum* (Cambodia, Indo-China); *dolichorhynchum* (peninsular Siam and Malaya); *ignipectus* (Indo-Chinese countries, southern China, Himalayas); *formosanum* (Formosa); *luzoniense* (Luzon); *bonga* (Samar); *apo* (Mt. Apo, Mindanao). In this species the upperparts are glossed with greenish blue, it

being the most distinct member of the superspecies in this respect. The rump is not red in the female. The derivation of this species is somewhat puzzling. The Philippine races bear a strong resemblance ventrally to *monticola*, but it seems rather unlikely that the species originated in the Philippines from *monticola* (Borneo) stock, then spread north through Formosa to China and back through southeastern Asia to Sumatra. On the other hand, the Sumatran and Malayan races resemble *D. sanguinolentum* ventrally. There is no trace of the red rump of females of *sanguinolentum* in any form of *ignipectus*, while the color of the back is also very different.

The Philippine and Formosan subspecies have an extensive red area on the breast and throat; in *ignipectus* and *dolichorhynchum* it is smaller and in *cambodianum* (not seen) and *beccarii* it has faded to cinnamon buff. Females are like those of *monticola* but even greener and lighter above. This species ranges as high as 12,000 feet in parts of Asia, but on Luzon ranges down almost to the lowlands.

SUMMARY OF *hirundinaceum* GROUP

This group of four closely related allopatric species probably was derived from the *cruentatum* species group in the general region of the Lesser Sunda Islands, where *D. sanguinolentum* bears a strong resemblance to *D. maugei* of the *cruentatum* group. The *hirundinaceum* group is characterized by the absence of a red rump in the males and by a tendency to lose it in the females. This mark still exists in the females of *D. sanguinolentum*, it is either absent or present, but pale, in the various subspecies of *D. hirundinaceum* of Australia and the nearby islands, and is absent in the females of the other two species. *D. hirundinaceum* resulted from colonization of Australia by *sanguinolentum* stock from the Lesser Sundas, probably Sumba. *D. celebicum* of Celebes, Borneo, and adjoining islands also seems to have been derived from *sanguinolentum* of the Lesser Sundas. *D. ignipectus* is more distinct, but seems closest to *sanguinolentum*, though in some races it is similar to *D. celebicum monticola*.

Aside from the disappearance of the red rump, the other color variation within the superspecies does not exhibit any very pronounced trends, but several of the characters are useful in trying to determine the interrelationships of the species, as shown above. The bill varies considerably within the species *sanguinolentum*. In the eastern part of their ranges, the *cruentatum* and *hirundinaceum* groups replace each other (except in the Lesser Sundas). *D. hirundinaceum* has reached Australia but avoided the Moluccas and Papua where the other group is present. The two groups coexist in the larger western islands and on the mainland—the *hirundinaceum* group usually at higher altitudes. In Celebes this is reversed, and *nehrkorni* of the *cruentatum* group ranges at higher levels, while *celebicum* occurs both in the lowlands and mountains.

ABERRANT GENERA

The three remaining genera of the Dicaeidae are aberrant. They appear to be specialized offshoots of the family and seem properly assigned to it. In all three the tenth primary is vestigial and the bill is not serrated. Two of them, *Oreocharis* and *Paramythia*, are monotypic and restricted to New Guinea. They seem to be strictly fruit eaters which suggests that they are distantly related to the fruit-eating primitive New Guinea genera, *Melanocharis* and *Rhamphocharis*. The third genus, *Pardalotus*, of Australia and Tasmania, though insectivorous, appears distantly related to *Oreocharis*.

OREOCHARIS SALVADORI (ARFAKI)

DIAGNOSIS: Tenth primary vestigial. Bill much as in *Melanocharis* but not serrated. The male has the head and throat glossy black with bright yellow cheek patches; underparts bright yellow with a medial chestnut brown area; back olive green; flight feathers dark with yellow patches near the tips of the secondaries on the outer vanes; tail dark washed with blue. In the female the throat and cheeks are gray; the upperparts similar to the male but the crown also green; the underparts duller yellow than in the male, with-

out chestnut and with the feathers margined with black.

The tail is rather short and the general appearance like that of a titmouse (*Parus*) in which genus the species was first described. There are hair-like filoplumes on the napes and flanks, a character tending to ally it with the Dicaeidae, as similar feathers are found in some species of *Anaimos* and *Dicaeum*. Tarsus booted except basally.

PARAMYTHIA DE VIS (MONTIUM)

As in *Oreocharis* there is only one species. It is endemic to New Guinea. The systematic position of *Paramythia* had been uncertain until Mayr (1933) showed that it resembles *Oreocharis* in so many respects that there can be no doubt it is a specialized relative of that genus. Similarity between the two had been casually indicated by one or two earlier authors.

DIAGNOSIS: Similar to *Oreocharis* but much larger and with a full nuchal crest of pointed feathers; tail relatively longer. In both sexes, which are colored alike, the head is black as in *Oreocharis*, but the bases of the crown feathers are white (a character suggested in the crown feathers of *Oreocharis*). The dull bluish coloration of the tail of *Oreocharis* has extended in *Paramythia* until it occupies the upper back and most of the underparts except the black throat and a small area on the belly and under tail coverts which are yellow as in *Oreocharis*. The back is similar to *Oreocharis* but duller. In immatures of *Paramythia* the breast feathers are tipped with yellow, suggesting a previous more extensive distribution of that color. There are long filoplumes on nape and flanks. Tarsus booted except basally.

PARDALOTUS VIEILLOT (PUNCTATUS)

SYNONYMS: *Dipardalotus* Mathews (*rubricatus yoriki*); *Nesopardalotus* Mathews (*quadragintus*); *Pardalotinus* Mathews (*striatus*). Mathews later synonymized these genera himself.

The genus *Pardalotus* is rather aberrant both structurally and in habits. It agrees with *Oreocharis* in lacking serrations on the bill and in the vestigial tenth primary.

Some of the species, such as *P. punctatus*, have terminal spots on the outer vanes of the secondaries, very suggestive of those of *Oreocharis*. In addition they have many other spots and streaks, producing a rather variegated pattern and suggesting the names *Pardalotus* and Diamond Bird. They are stumpy, short-tailed, and short-billed little birds and thus resemble to some extent their rather distant relatives, *Dicaeum*. The internal anatomy has apparently not yet been studied.

DIAGNOSIS: Bill not serrated; short, deep, with strongly arched culmen and sometimes slightly compressed (modified for burrowing). Tenth primary vestigial. Small, short-tailed, rather long-winged birds, similar to *Dicaeum* in proportions but averaging somewhat larger. Sandy-colored birds, often with bright yellow, especially on the throat and sometimes tiny yellow or red marks on the wing coverts; crown, wings, and tail usually black, much spotted and streaked with white; feet and claws stout. The tarsus appears booted in dried skins, but this may be deceptive.

THE SPECIES OF *Pardalotus*

The seven species of *Pardalotus* can be divided into two groups, the spotted-wing group (*punctatus* and *quadragintus*), and the striped-wing group (the other five species). Since the spotted-wing pattern is very similar to that of *Oreocharis arfaki* (New Guinea) it seems likely that this is the more primitive pattern. The two groups are quite similar, except for the

wing. The proportions are the same; there is a tendency for a light-colored rump and for white tail tips.

1. *Pardalotus punctatus*. Eastern, south, and southwest Australia, Tasmania. The arid country form *xanthopygius* appears to be a race of this species. Male and female are strikingly distinct in this species. The superciliary is indistinct.

2. *Pardalotus quadragintus*. Tasmania. Male and female are hen feathered and rather similar to the female of *punctatus*. This is probably another case of double invasion on Tasmania, with *quadragintus* the first, and *punctatus* the second colonization. The primitive color of this species appears to be a secondary simplification.

3. *Pardalotus rubricatus*. North and central Australia to New South Wales. This arid country species leads in some respects from the spotted to the striped pardalotes. The superciliary with the loreal spot (reddish in this species) is, however, typical for the striped pardalotes. There is no sexual dimorphism.

4. *Pardalotus striatus*

5. *Pardalotus ornatus*.

6. *Pardalotus substriatus*. The differences, the geographical distribution, and the reasons for the specific distinctness of these three species have been discussed recently by Hindwood and Mayr (1946).

7. *Pardalotus melanocephalus*. This more or less tropical species with the plain black crown is very close to the other three striped pardalotes, particularly to *substriatus*. It ranges from northwest Australia through northern Australia into northern New South Wales.

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NEW SPECIES OF *VOLUCELLA* FROM HAWAII AND THE UNITED STATES (SYRPHIDAE, DIPTERA)

By C. H. CURRAN

Up to the present time, the only volucelline fly recorded from Hawaii is *Ornidia obesa* Fabricius, which appears in the literature as *Volucella obesa*. This species is widely distributed in tropical America and over many of the Pacific islands. Study of a series of specimens from Mr. F. X. Williams, tentatively determined as *V. johnsoni* Curran, showed that two species were present in the lot, both different from any species from tropical America. However, representatives of one of them, captured in Lower California, have been received from Dr. E. S. Ross of the California Academy of Sciences.

Both species are related to the species I have determined as *tricincta* Bigot. In both there is a strong transverse depression before the apex of the scutellum. In one of the species there is a large, subtriangular depression on each side of the scutellum; in the second these are represented by weak transverse depressions. The species of *Volucella* with these characteristics are confined to tropical and subtropical America, so it is obvious that both species were introduced from America, but the manner in which they reached Hawaii is unknown.

Nothing is known about the biology of this group of species, but the adults have the habit of sitting on the tips of dead twigs, and they also spend the night in such places. I have never taken them at flowers, but most of the specimens captured in Hawaii were on flowers of *Hoya*.

The continental species included herein are common species represented in collections under the name *vesiculosa* Fabricius. *V. vesiculosa* is a South American species which apparently belongs to a different species group than the United States species. The types are in the American Museum of Natural History.

The following key will separate the volucelline flies so far known to occur in Hawaii:

1. Bright metallic green, blue or violaceous; face with lateral swellings....
.....*Ornidia obesa* Fabricius
Not bright metallic; face without lateral swellings; scutellum with preapical depression.... 2
2. Scutellum with lateral depressions almost as long as wide; femora black on basal third or more; frontal triangle of male yellow.....
.....*hoya*, new species
Scutellum with weak transverse lateral depressions; femora all reddish; frontal triangle of male black or brown.....*dracaena*, new species

Volucella hoyae, new species

Yellowish, with brown and ferruginous markings, the mesonotum trivittate; scutellum with three depressed areas, the lateral ones almost as long as wide; femora broadly shining black basally. Length, 6.5 to 7 mm.

MALE: Frontal triangle small, rusty yellowish, with whitish pile; vertical triangle black or brown, small, the pile white in front, rusty yellowish at the vertex. Occiput cinereous pollinose, with very short white pile, but it becomes longer towards the cheeks. Cheeks moderately wide, with long pile behind and extremely short pile in front. Face and cheeks reddish yellow, separated by a brown line that is usually obsolete towards the oral margin; face strongly produced downward and forward, sharply conical, with a large tubercle on the median third; upper concavity rather deep, white pollinose; pile rather sparse, white, more or less yellow on the tubercle. Antennae pale orange; the third segment slightly tapering, about two and one-half times

longer than wide; arista with the rays and apex black. Eyes thickly whitish pilose.

Thorax yellowish; disc of mesonotum with three ferruginous vittae, the lateral ones black or brown on the outer side, the median one shorter and broader and usually black or brown posteriorly; the dark color may extend over almost all of the vittae; the pectus is black and this color extends broadly to the posterior spiracle, which is brown. Pile whitish on the pleura, very pale brassy yellow on the mesonotum, a few black hairs towards the sides and a band of black hair before the scutellum. Scutellum brown or blackish, the sides and venter pale reddish; a large pyriform reddish spot covers the middle, its broad end covering the preapical depression, the narrow end reaching the very narrowly reddish base; the large lateral flattened areas are strongly roughened, the apical depression rather deep; hair whitish with slight brassy tinge; black on the sides. All the bristles on the thorax and scutellum are black.

Coxae yellow, the anterior pair more or less extensively brown apically, the middle pair usually brown on the outer half; femora black basally, the anterior pair on about the basal third, middle pair on slightly less than half, and the hind pair on somewhat more than the basal half, the apices reddish; tibiae brownish red, the apices more or less darkened; tarsi blackish, the base brownish yellow. Pile of the legs black, yellow on the coxae.

Wings cinereous hyaline, the veins bordered with brown, the cross veins at the middle of the wings a little more heavily bordered; stigmal spot brown; marginal cell closed and petiolate. Squamae with slight brown tinge, the fringe brown. Halteres white.

Abdomen rusty reddish yellow, the two basal segments yellow except laterally; the second segment with a blackish posterior fascia occupying the posterior third but not reaching the lateral margins; third segment with the posterior fifth and narrow lateral margins black, and with a broad, subbasal band on the median half, this band sometimes reduced in size; fourth segment with an irregular, incomplete,

subbasal brown band and an apical fascia that is widest in the middle, rarely produced forward to touch the anterior band. Pile whitish, somewhat brassy laterally. Venter yellow, white pilose, the fourth sternite brown or black and black haired. Genitalia large, reddish to ferruginous, the hair black.

FEMALE: Front brown or black, except on the narrow anterior border, the pile short and white. Anterior brown bands on segments three and four broader, the yellow band on the fourth narrower than either brown band; fifth segment all brown; pile shorter, black on the extreme lateral margins of the third and following segments.

TYPES: Holotype, male, Honolulu, March 3, 1946, at *Hoya* flowers (F. X. Williams); allotype, female, Mokuiaia, Oahu, May, 1946 (R. H. Vanzwal); paratypes, three males, Honolulu, March 3, 1946, and February 3, 1946 (Williams); male and two females, Las Animas, Sierra Laguna, Lower California, October 12, 1941 (Ross and Bohart), and one male, July 26, 1938 (Michelbacher and Ross).

This species belongs in the group which includes *tricincta* Bigot, and it closely resembles certain forms of that species. It is readily distinguished by the whitish pilose front, large genitalia, and color of the femora.

***Volucella dracaena*, new species**

Rusty reddish or reddish yellow, the mesonotum with three ferruginous vittae; lateral depressions on the scutellum transverse, sometimes only faintly indicated; marginal cell open; legs dark reddish. Length, 5.5 to 7.5 mm.

MALE: Frontal and vertical triangles brown or blackish, pale yellowish pilose. Occiput cinereous to ochraceous pollinose, the pile pale yellowish, very short above; several black occipital cilia above. Cheeks moderately wide, sometimes brownish posteriorly, the hair brassy yellow, but there are usually some black hairs intermixed near the eyes. Face reddish yellow, strongly produced forward and downward, the tubercle of medium size; face and cheeks separated by a more or less distinct

brown line, the face moderately concave above; pile sparse, brassy yellow. Antennae reddish, the third segment about twice as long as wide; rays and apex of the arista black. Eyes with short, dense, reddish brown pile.

Thorax rusty reddish, the broad sides of the mesonotum luteous, the humeri pale yellow. Mesonotum with three ferruginous vittae, the median one short and usually gemminate. Pile black, on the disc of the mesonotum mostly brassy yellowish; wholly yellow adjacent to the humeri and on the propleura. Scutellum brown, somewhat metallic, with a large rusty reddish pale spot that varies somewhat in shape but is always narrower in front; sides of the thorax reddish; hair black, brownish red or yellow on the apex. The basal depressions are sometimes quite weak and never more than one-fourth as long as wide; the apical depression, when viewed from the side, is on a horizontal plane, not concave as in many of the species.

Legs reddish, but somewhat variable, usually with brownish or fuscus tinge; the apical four segments of the front tarsi, two of the middle, and three of the hind pair black or brown. Hair black; yellow on the apical half of the posteroventral surface of the posterior tibiae.

Wings cinereous hyaline, the veins reddish brown basally, becoming brownish yellow or dull yellowish towards the apex of the wing, the costa yellowish beyond the small stigmal spot. Squamae brownish, with black fringe. Halteres yellow, with white knob.

Abdomen rusty reddish yellow, pale rusty reddish, or dark rusty reddish, the first segment and the second, except on the broad sides, yellowish; second segment with the apical fourth brown or ferruginous, with black apex; third segment with a slightly narrower apical fascia, the fourth at most very narrowly dark at the apex. Pile white; brown or black on the sides of the second segment basally; darker on about the apical half and broad sides of the third segment and on the broad base of the fourth, the color varying from tawny to black. Venter yellowish to dull reddish, usually darker apically; pile yellow on the

basal two or three sternites, black apically. Genitalia rather small, brownish yellow, the hair black.

FEMALE: Front shining black, usually ferruginous along the orbits and about the ocelli, narrowly reddish in front, the pile white. There is less black pile on the thorax, the disc usually being all pale haired, and the scutellum has pale pile except on the broad sides. Abdominal pile all whitish; narrow apices of the fourth and fifth segments black.

TYPES: Holotype, male, Honolulu, December 31, 1946, at *Dracaena* flowers (F. X. Williams); allotype, female, Honolulu, March 3, 1946, at *Hoya* flowers (Williams). Paratypes, eight males and four females, Honolulu, February 3, 1946, March 3, 1946, and December 31, 1946 (Williams); one male, December 20, 1946 (R. H. Van Zweluwenburg); male and female, Makiki, Oahu, February 4, 1946 (Williams).

In all the specimens the thorax appears moderately violaceous when viewed in some lights; the vittae are rarely darkened, but when so the whole disc of the mesonotum appears blackish when viewed without magnification.

THE *V. vesicularia* GROUP

At the time I described *V. barei*, I compared it with the species that was generally identified as *vesiculosa* Fabricius and that is still so named in collections. A comparison of specimens from the United States with the original description shows that our species cannot possibly be *vesiculosa*, which was described from South America, and which must be closely related to *correcta* Curran. I am therefore describing our common and widely distributed species as *vesicularia*.

Volucella vesicularia, *barei*, and *vesiculana*, new species, form an interesting, small group in the genus *Volucella*. They are separated from all other known species by the remarkable thickening of the outer half of the lower squama. The thickened portion is convex below and flat above but with a concavity anteriorly. It varies in color from yellow through orange to dark rusty red. The upper eye facets of the

males are enlarged, less so in *vesicularia* than in the two other species, and with short, rather thick pile. The abdomen is usually a little broader than long and conspicuously wider than the thorax, which has a brilliant green and violaceous opalescence.

The three species may be separated as follows:

TABLE OF SPECIES OF THE
vesicularia GROUP

1. Pleura of male wholly black pilose, abdomen dark metallic green, with black base; lower lobe of squamae rusty red on swollen area; scutellum with black hair.....*barei* Curran
Pleura mostly or wholly yellow pilose; abdomen ferruginous or brown with green and violet opalescence and pale base; lower lobe of squamae yellow to orange; scutellum pale haired.....2
2. Basal two visible sternites yellow, or if dark then the first sternite brown, the second yellow in the middle; enlarged eye facets of medium size.....*vesicularia*, new species
Basal visible sternite luteous, the following all with strong opalescence; upper eye facets greatly enlarged.....*vesiculana*, new species

***Volucella vesicularia*, new species**

Volucella vesiculosa of authors, not Fabricius.
Volucella vesiculosa MACQUART, 1848, *Diptères exotiques nouveaux ou peu connus*, suppl. 3, p. 39; WILLISTON, 1886, *Synopsis of North American Syrphidae*, p. 141.

Metallic greenish with violaceous reflections, and appearing violaceous when viewed without magnification; base of abdomen yellow; wings clear with small stigmal spot. Length, 8.5 to 11 mm.

MALE: Face and frontal triangle reddish yellow, the face white pollinose in the depression, the pile pale brassy yellow. Vertical triangle black, black pilose, but several pale hairs in front. Occiput black, cinereous pollinose, the pile white; there are no long cilia above. Cheeks rather narrow, brownish behind. Face produced moderately downward, the large, low tubercle lying partly below the lower edge of the eyes; in profile the face is rather gently

concave above and perpendicular below the tubercle. Antennae orange, the third segment greatly constricted in the middle; arista with black rays and apex. Eyes with tawny pile.

Thorax reddish brown, mostly with very strong opalescent green sheen; the prothorax, sides of the mesonotum behind the suture, and the upper half of the pleura behind the base of the wings yellowish, the humeri whitish. Pile pale brassy yellow; a row of black, bristly hairs and shorter black hairs in front of the scutellum, and some black hair below the base of the wings and on the upper part of the mesopleura. Scutellum translucent light brownish, with the disc opalescent; hair black, yellow on the apex. All the bristles are black, and there may be a few scattered black hairs towards the sides of the mesonotum.

Legs reddish, the apical three or four segments of the tarsi brown; anterior four femora brown on about the basal half, the hind pair on the basal four-fifths. Hair black; pale yellowish on the posterior coxae and on the basal half of the posterior surface of the middle femora.

Wings hyaline, the veins reddish yellow; a weak brown cloud extends from the stigmal spot over the anterior cross vein; cross veins at middle of wing brown; stigma pale luteous.

Abdomen opalescent green, with violaceous reflection, the first segment and broad base of the second luteous or yellowish. Pile thick, short, white. Venter yellowish basally, becoming rusty brownish and more or less metallic apically. Genitalia rusty brown to dark brown, the hair black.

FEMALE: Front reddish yellow to greenish yellow, darker and more or less rusty above, very slightly narrowing upwardly. Hair pale yellowish, sometimes black at the vertex; scutellum usually all yellowish haired.

TYPES: Holotype, male, Station for Study of Insects, Tuxedo, New York, June 30, 1928 (Curran); allotype, female, Ramsey, New Jersey, June 23, 1925. Paratypes, male, Avon Old Farms, Connecticut, June 18, 1929 (Curran); male, Cold Spring Harbor, Long Island, August 9, 1930; male, Beltsville, Maryland, June,

1936 (W. M. Davidson); male, Dyer, Indiana, June 4, 1899, in the American Museum of Natural History; male and two females, North Carolina; male, C. V. Riley Collection; female, Offutt's Island, Maryland, July 8, 1919 (H. S. Barber); female, Bowie, Maryland, May 31, 1945 (DDT Exp.); male, Washington, D. C., August 29, 1926 (J. M. Aldrich); female, Washington, D. C., August 19, 1911 (F. Knab); female, Linglestown, Pennsylvania, July 26, 1911 (W. S. Fisher); male, Connecticut, June 18 (Williston Collection); male, Plummer's Island, Maryland, June 24, 1916 (R. C. Shannon) in United States National Museum; female, Oakwood, Illinois, June 18, 1926 (Frison and Hayes), in Canadian National Collection; five males and six females, Flint, Oklahoma, July 15, 1934 (J. Stankavich); one female, Flint, June 14, 1934; male, Wilburton, Oklahoma, June 13, 1934, and two males and one female, Broken Run, Oklahoma, June 18, 1934 (A. E. Pritchard); female, Broken Run, June 17, 1934 (J. Stankavich); male, Fernville, Michigan, June 2, 1929 (L. G. Gentner); two females, Madison, Wisconsin, August 28, 1917, and July 18, 1943, and one female, Rhineland, Wisconsin, July 18, 1946 (C. L. Fluke), female, Atlanta, Georgia, July 4, 1935 (P. W. Fattig), in C. L. Fluke Collection; five males and seven females, Douglas County, Kansas, July 15 to 23, 1942 (R. H. Beamer); male, no locality (S. W. Williston), and male, Barnes, Arkansas, June 8, 1932 (R. H. Beamer) in Kansas University Museum; male, Kentucky, and two females, Pennsylvania (Osten Sacken Collection); male, Philadelphia, Pennsylvania, June 24, 1911, male, Riverton, New Jersey, June 29, 1889, and female, Delaware Water Gap, New Jersey, July, 1918 (C. W. Johnson Collection); female, Cold Spring Harbor, Long Island, August 9, 1930 (J. Bequaert); female, Glencaryn, Virginia, June 28 (N. Banks); female, Wellesley, Massachusetts, June 8, 1913 (W. G. Bolster); female, LaSalle County, Illinois, July 7, 1938 (F. G. Werner) in Museum of Comparative Zoölogy; male, Lake Forest, Illinois, July 9, 1904 (J. C. Needham), and male, Ithaca, New York, June, 1902,

in Cornell University Collection; two males, three females, Oxford, Mississippi, May, 1944 (F. M. Hull); female, Ranken, Missouri, July 15, 1934 (E. P. Meiners).

There is some variation in the extent of the black or brown on the legs; it may extend much more than halfway from the base on the anterior four femora, and all the tibiae may be darkened on the apical third or more. In one very dark specimen, the first visible sternite is brown, the second yellow in the middle and slightly metallic on the sides.

Volucella vesiculana, new species

This species is so similar to *vesicularia* that a comparison with that species will serve as well as a full description.

The face is not produced downward quite so much, and the eye facets in the male are much larger and run in an almost straight line from the corner of the eye to the frontal triangle (in *vesicularia* they are strongly curved above owing to the smaller size of the upper facets). The thorax is always paler, ferruginous or lighter, and the opalescence is less strongly evident, being very slight on the scutellum. The base of the abdomen is reddish yellow, rather than pale luteous, while the remainder of the abdomen is usually much more green, and the violaceous opalescence is generally much less apparent. The sternites, except the first visible, are all metallic, the first being reddish.

Types: Holotype, male, and allotype, female, Globe, Arizona, July 30, 1933 (F. H. Parker); paratypes, male, Santa Rita Mountains, Arizona, June, in the American Museum of Natural History; male (headless), and female, Texas (Belfrage) in the United States National Museum; 44 males, 32 females, Santa Rita Mountains, Arizona, June (F. H. Snow), in the Canadian National Collection, California Academy of Sciences, and the University of Kansas Museum; seven males and one female, Palmerlee, Arizona, July (J. Bequaert and N. Banks), and one female, Blanco County, Texas (C. W. Johnson Collection), in the Museum of Comparative Zoölogy.

The coloration of the second visible sternite serves as a ready means of separat-

ing *vesicularia* and *vesiculana*. In the former it is always yellow in the middle, usually very broadly pale yellow with the first sternite pale yellow, or brown when the second is broadly dark laterally. In *vesiculana* the second visible sternite is normally all metallic, but if reddish in the middle, the first sternite is also reddish or rusty reddish yellow. The males are readily separated by the difference in the size of the eye facets.

***Volucella barei* Curran**

Volucella barei CURRAN, 1925, Canadian Ent., vol. 57, p. 255.

This species was originally described from two males from Texas and Kansas. I have before me a male collected by Dr. Frank M. Hull at Oxford, Mississippi, and am informed that the species is fairly common.

In the United States National Museum there are two specimens from Florida that I place here with considerable doubt. The male is quite small, only 7.5 mm. in length,

and has the upper eye facets only slightly enlarged. The female is unusually large, about 11.5 mm., and with the spot at the middle of the wing twice as large as usual. In all the males of *barei* I have seen, the upper eye facets are greatly enlarged and the anterior median wing spot is little more than a broad line. Until more material is available for study, I prefer to place the specimens under *barei* for the present.

There is a possibility that *barei* may prove to be the same as *opalescens* Townsend, described from New Mexico, but Townsend compares his species with Mexican forms which have a preapical scutellar depression and normal squamae. Unless the type of *opalescens* can be found, the species must remain unidentifiable.

ADDITIONAL RECORDS: Male, Kilborton, Oklahoma, June 9, 1934 (A. E. Pritchard); female, Yonah Mountain, Georgia, June 22, 1935 (P. W. Fattig), in C. L. Fluke Collection; three females, Oxford, Mississippi, May, 1944, and June, 1946 (F. M. Hull).

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FOUR NEW PIERIDAE FROM THE WEST INDIES

BY EUGENE G. MUNROE¹

During recent studies on the West Indian fauna, the following new forms were encountered. Portions of the type series of all are in the collection of the American Museum of Natural History.

Phoebis (Aphrissa) orbis browni, new subspecies

MALE: Average size larger than that of *orbis orbis* from Cuba. Fore wing above with yellow triangular area deeper in color and more prolonged apically. Ground color of under side yellow and with reddish markings less strongly contrasting than in the majority of Cuban specimens; reddish subterminal line, however, better developed in the new subspecies. Outer margin of hind wing more strongly convex than that of *orbis orbis*.

FEMALE: Decidedly larger than Cuban females. Black border of fore wings continued for a varying distance along costa. Under side with brownish markings less extensive than in typical *orbis*, at least in the material examined; nacreous scaling along outer margin of both fore and hind wings considerably more pronounced than in Cuban specimens.

MALE GENITALIA: Very similar to those of typical *orbis*, but with the reflexed dorsal process of the valve shorter, not extending past the costa of the valve, and with the base of this process broader.

HOLOTYPE MALE: Pivert, Haiti, 250 feet, April 1, 1922; genitalia slide B1180, F. M. Brown; in the American Museum.

ALLOTYPE FEMALE: Pétionville, Haiti, July 3, 1930; in the American Museum (collection F. E. Church).

PARATYPES: One male, Fond Parisien, Haiti, February 11-18, 1922; genitalia preparation 609, E. Munroe. One female,

Chacquey, Dominican Republic, February 26, 1930 (Stillman); genitalia slide B1357, F. M. Brown. Both in American Museum. One male, Barahona, Dominican Republic, June 7, 1940 (Needham); in Cornell University collection.

This subspecies appears to be confined to the Island of Hispaniola. It is named for Mr. F. Martin Brown in recognition of his important contributions to the classification of the genus *Phoebis*.

Phoebis (Aphrissa) statira hispaniolae, new subspecies

MALE: Head black above, with several red spots; palpi yellow; antennae with dark shaft and pale fulvous club. Thorax black above, clothed with long, gray hairs giving a greenish effect; beneath yellow. Wings above bright yellow, mealy area somewhat paler than unmodified part of wings, but not contrastingly so in the majority of specimens; rarely the mealy area almost white. The usual sex patch above RS of hind wings, varying from whitish to pale pinkish brown in different individuals. Beneath, both pairs of wings almost uniform yellow, except for the posterior region of the fore wings, which becomes whitish towards the inner margin. Fore wings with an inconspicuous yellow or orange discocellular spot, often bordered externally by a faint brown line; a similar spot on the hind wings, lacking the brown line. Occasionally the fore wings above have an extremely narrow black apical border.

FEMALE: Wings rather pale yellow; antennae lacking the fulvous tips. Fore wings above with a large black discocellular spot, and with a distinct apical and distal marginal line; beneath with a rusty discocellular spot and faint, interrupted, rusty, postmedial and terminal lines. Hind

¹ Macdonald College, Quebec, Canada.

wings beneath with a white discocellular spot and a faint, interrupted, rust-colored, postmedial line.

This subspecies, occurring in Hispaniola and perhaps in Puerto Rico, belongs to a subspecies group which also includes *statira cubana*, *statira floridensis*, and the Central American *statira jada*. The new subspecies is larger than any of these and differs especially in the bright yellow ground color of the male fore wing beneath, the remainder of the wing not being contrastingly duller than the cell as it is in the other subspecies. From *Phoebis neleis*, with which it has been confused by some authors, *hispaniolae* and all *statira* subspecies may be distinguished by the absence of the pink spot at the base of the hind wings beneath, which is characteristically present in members of the *neleis-orbis* complex. So far as the writer is aware, *neleis* does not occur in Hispaniola, being confined to Cuba, the Bahamas, and (according to Carpenter and Lewis) the Cayman Islands.

The male genitalia of *hispaniolae* are essentially similar to those of the other subspecies of *statira*.

HOLOTYPE MALE: Sanchez, Dominican Republic, June 24–26, 1915; in the American Museum.

ALLOTYPE FEMALE: Sanchez, Dominican Republic, June 30–July 4, 1915; in the American Museum.

PARATYPES: Six males, same locality and month as holotype. One male, San Lorenzo, Dominican Republic, June 24–26, 1915. All the above types in the American Museum. Genitalia preparations 575, E. Munroe, and B1183, F. M. Brown, made from among these paratypes.

One male, "San Domingo. Gift of H. C. Fall." One male, "San Domingo, A. G. Weeks Collection"; M. C. Z. slide no. 292. These two paratypes are in the Museum of Comparative Zoology, Cambridge, Massachusetts.

Not included in the type series is one female in the American Museum, reared in Puerto Rico (at Rio Piedras?) by G. N. Wolcott on *Melicocia bijuga* L. This specimen does not appear to differ in any important respect from *hispaniolae*, but in

the absence of further material the status of the Puerto Rican *statira* population must remain in doubt.

Eurema (Abaeis) nicippiformis,
new species

MALE: Palpi yellow, more or less flushed with pink; vertex pink; antennae with club and upper surface of shaft pinkish brown, lower surface of shaft with segmental light and dark bands. Upper surface of wings orange, with a blackish marginal band; fore wing with a varying degree of blackish suffusion in the costal area, the suffusion never heavy; veins yellow scaled; a slender black discocellular bar; dark border of wings narrower than in *nicippe*, especially in cell A_1 and along the inner margin; fringe pinkish, becoming yellow towards the tornus. Hind wing orange with yellow anal area; veins concolorous with remainder of wing, except for a weak dusting of yellow and black scales about the base of Cu; dark marginal area about half the width of that of most individuals of *nicippe*, more or less crenulated internally but entirely lacking the conspicuous projection into cell M_2 characteristic of that species. Under side indistinguishable from that of *nicippe*. The male resembles the corresponding sex of *nicippe*, but can be distinguished immediately from typical individuals of that species by the narrow and regular marginal band. Mr. Ralph Chermock states (personal communication) that a similar narrow and regular band frequently occurs in Californian specimens of *nicippe*. The writer has not examined such specimens and is therefore unable to judge how closely they approach *nicippiformis* in this character.

FEMALE: Closely similar to that of *nicippe*, from which it differs in the following respects:

1. The veins of the fore wings above are yellow scaled, contrasting with the orange ground color; in *nicippe* these veins are almost invariably orange scaled, concolorously with the ground.

2. The discocellular bar of the fore wings above is longer and relatively narrower than in *nicippe*.

3. The dark costal shading of the fore

wings and the dark marginal band of the hind wings and fore wings are less extensive than in the majority of specimens of *nicippe*.

4. The dark subterminal spots in cells M_3 and Cu_1 of the hind wings beneath are much less pronounced than those which form an oblique interrupted bar from cell M_1 to cell Cu_2 . In *nicippe* these two groups of spots are of the same order of intensity in any one individual.

MALE GENITALIA: Costa of valve approximately at right angles, distal margin approximately parallel, and ventral margin approximately at 70° to the base. Distal process and lobe "e" (terminology of Klots) directed inward at right angles to the body of the valve, and crossed scissor-wise; space between distal process and lobe "b" rather narrow and angular, but with the extreme apex of the indentation rounded. Lobe "a" about one-half the length of the distal process; the latter pointed, shorter and broader than lobe "e." Lobe "b" with no dorsal tooth at its base. Uncus pointed, free part rather long and decurved. Sacculus about same length as valve.

The male genitalia of *Eurema nicippe* differ in the following respects from those of *E. nicippiformis*. The costa of the valve in *nicippe* is at an angle of about 75° to the base, the distal margin at about 10° , while the ventral margin is angled at the middle, with the basal part at about 65° , the distal part at about 50° to the base of the valve. The distal process and lobe "e" are bent at less than right angles to the body of the valve; they are crossed, but not so closely appressed as in *nicippiformis*. Lobe "e" is pointed, nearly as long as, and broader than, the distal process, but not so broad as in *nicippiformis*. The space between the distal process and lobe "b" is broad and U-shaped; lobe "b" has a distinct dorsal tooth at its base. The free part of the uncus is somewhat broader than in *nicippiformis*.

HOLOTYPE MALE: Ravine of Pétionville, Haiti, ca. 1600 feet, January 24–29 1922; genitalia preparation 611, E. Munroe; in the American Museum.

ALLOTYPE FEMALE: Pétionville, Haiti, November 7, 1933 (Ducasse); in Carnegie Museum, Pittsburgh.

PARATYPES: One male, Monte Christi, Dominican Republic, May 6, 1915. One male, Dessources, Haiti, March 2, 1922. One female, Rio Yaque, 10 miles south of Monte Christi, Dominican Republic, March 12, 1931 (Stillman). These three in the American Museum. Two males, one female, Delmar, Haiti, October 30, 1933 (Ducasse); male genitalia preparations 612 and C5, E. Munroe. One female, Port-au-Prince, Haiti, November 6, 1933 (Ducasse). Two females, Port-au-Prince region, Haiti, October 28, 1933 (Ducasse). These six in the Carnegie Museum, Pittsburgh.

This species is so close to *E. nicippe* that the writer at first supposed it to be only a subspecies. He now considers it to be specifically distinct for the following reasons:

1. The genitalic differences between the two, although subtle, are at least as large as those characterizing valid species in several other groups of the genus, notably in the *dina*, *daira*, and *salome* groups.

2. The range of true *nicippe* includes and extends beyond that of *nicippiformis*. The writer has examined specimens of *nicippe* from Cuba, Hispaniola, Jamaica, and Puerto Rico, although the species appears to be of regular occurrence only in the first of these islands.

***Eurema (Pyrisitia) euterpiformis*,
new species**

Terias euterpe HALL (1925) *nec* Ménétériés (1832).

MALE: Of about the size and general appearance of *Eurema lisa*. Head black above, with a number of long scales of a deep wine color; palpi yellow, faintly pink beneath; antennae dark reddish brown. Thorax black above, with some grayish hairs; beneath yellow; legs straw colored. Abdomen with dorsum black to the mid-lateral line, ventral half yellow. Fore wings above brilliant clear yellow, lacking the greenish tint characteristic of most yellow species of the genus, but on the other hand without any orange flush; base narrowly, but rather conspicuously, dusted with black; costa narrowly, but distinctly, black; outer margin with a black border,

about as wide as that of *lisa* in the paratypes, somewhat narrower in the holotype, but in all specimens as wide at inner margin as at M_3 , instead of being strongly attenuated behind as in *E. lisa* and *E. neda* (*nise*, *sensu* Klots). Hind wings above of the same clear yellow; a short streak of black dusting extends from base into anal area; black border narrow, becoming more attenuated posteriorly, extending approximately from RS to Cu_2 . Both wings beneath yellow, paler and greener than above; a minute black dot on the middle discocellular of each wing, a further one at the base of the humeral vein of the hind wing; hind wings beneath faintly dusted with black scales, and with a small reddish brown patch before the tip of SC.

FEMALE: Unknown.

MALE GENITALIA: Tegumen dorsally incomplete; uncus with central part membranous except at tip, so that it assumes a V shape, instead of a Y shape as in all other *Eurema* species known to the writer. Saccus rather short, clavate, with a scoop-shaped, rather well-sclerotized anterior process, extending under the bases of the valves. Valve deeper than long, with a long slender dorsal ligament; costa evenly and very gently curved, at an average angle of more than 80° to the base; outer and ventral margins meeting at a barely perceptible angle, both rather evenly curved; distal process short and extremely narrow, that of right valve (in the holotype) with two small teeth, that of the left valve with one; lobe "d" long, slender, sharply pointed, almost at right angles to the body of the valve, but directed slightly caudad; lobe "e" similar, but a trifle shorter and more slender, and directed at almost the same angle cephalad; lobe "b"

less than half the length of "e," situated directly over it; lobe "a," although slender, is the longest and stoutest of the lobes.

HOLOTYPE MALE: Kenscoff, Haiti, 4826 feet, "3/10/35"; genitalia preparation 562, E. Munroe; in the American Museum.

PARATYPES: One male, Ennery, Haiti, 2500 feet, August (Bates). One male, Furcy, Haiti, 5500 feet, September (Bates). Both in the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

This species is known only from Hispaniola, where it is apparently confined to the higher altitudes; in addition to the localities cited above, Hall records it from pine forests of La Vega, Dominican Republic.

Although *euterpiiformis* clearly belongs to the *dina* group, its more precise affinities are obscure. The strong superficial resemblance to *lisa* led Hall to misidentify the species as *euterpe* Ménétriés, but, as pointed out by Comstock (1944, p. 523), Ménétriés' 1834 figure clearly represents a male of *lisa* of the dark West Indian type. The new species may be distinguished from both *lisa* and *neda*, which it most closely resembles externally, by the configuration of the marginal band of the fore wings, as pointed out in the description. The male genitalia, on the other hand, resemble most closely those of the superficially dissimilar *Eurema laeae* of Cuba, with which they agree in the proportions of the valve and the shape of the anterior process of the saccus, but from which they differ in the shorter and stouter saccus, in the shorter and broader dorsal ligament of the valve, and particularly in the unique character of the shape of the uncus.

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AMERICAN MUSEUM NOVITATES

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THE SEASONAL INCIDENCE OF SNAKES

BY JAMES A. OLIVER

INTRODUCTION

Few data dealing with the seasonal fluctuations in the occurrence of reptiles are available. Studies of such fluctuations are of great value in estimating the relative importance of ecological factors influencing the activities of ectothermal animals. Moreover, these studies are of practical importance to the medical practitioner who is responsible for the effective treatment of snake-bite, to the commercial collector who must utilize his efforts most profitably, and to the systematic herpetologist who likewise wishes to apply his time and efforts most efficiently, as well as to learn all the details about the animals he studies. Existing information on this subject is primarily the result of investigations concerned with reptiles of the northern latitudes where marked fluctuations exist in temperature and rainfall. Very little is known of the species occurring in those tropical climates where slight variations in temperature and rainfall are the rule. Data for a species of snake living in a tropical climate with little variation in temperature have recently been made available by my colleague, Dr. Harvey Bassler. These will be analyzed in connection with other data derived from studies of snakes in different climates, supplemented with a review of the major sources of published observations on this subject.

It is perhaps unnecessary to point out that these data raise more questions than they answer. Nonetheless, they are of

value in pointing to problems that require solution. There is need to stress the obvious fact that the fluctuations in the number of specimens obtained per month do not necessarily indicate variation in population size or in the activity of snakes. It may be related to either or to both. Under favorable conditions, however, more specimens can be obtained at periods of maximum activity than at periods of minimum activity.

Throughout this study the word "temperature" refers to air temperatures. Klauber (1939), in discussing reptile activity in the southwestern United States, has pointed out that "a high temperature in the early spring will not bring out the reptiles before the ground temperature has had time to rise." Cowles and Bogert (1944) have further amplified the subject with respect to the importance and complexity of environmental temperatures in relation to body temperatures and the activities of reptiles. These authors have shown that air temperatures provide only an approximation of the body temperatures that govern the activities of the organism. Unfortunately air temperatures are the only data recorded for many studies previously published, and the observations reported herein are, of necessity, restricted to conclusions based on such information. Despite the imperfections of these data, they do afford an approximate indication of the thermal level of a reptile's environment.

MATERIAL

The data presented herein are based on 83 well-documented specimens of the snake *Thalerophis richardi nigromarginatus* (= *Leptophis nigromarginatus* of

authors) collected in the vicinity of Iquitos, Peru, by Dr. Harvey Bassler of the American Museum of Natural History. I am indebted to Dr. Bassler for the privilege of

examining this material. Dr. Bassler was a resident of Iquitos for 10 years, and he states that the intensity of collecting was virtually the same throughout each year. In the unusually large assemblage of amphibians and reptiles gathered by him,

there are sizable numbers of individuals of various species recorded for each month of the year. Therefore a minimal effect from seasonal fluctuations in the human activity associated with the collection of the material is indicated.

SEASONAL INCIDENCE OF *THALEROPHIS RICHARDI NIGROMARGINATUS*

The data are shown graphically in figure 1 and are summarized in table 1 together with the climatic data for Iquitos, Peru.¹ The most prominent features are the increase in the numbers of these snakes captured in March and the absence of any uniformity in the numbers recorded for the different months. Aside from chance, inherent in small samples, it might have been expected on theoretical grounds that in a climate with relatively uniform temperatures and no dry season, the monthly occurrence of snakes would be virtually constant. Examination of the detailed climatic data for Iquitos reveals the fallacy of this supposition; whereas the mean monthly temperature varies relatively

little (2.4° C.), there is a pronounced (190 mm.) monthly variation in rainfall, despite the absence of a dry season. The maximum monthly rainfall occurs in March and may be associated in some manner with the peak in occurrence of the snakes.

Direct comparison of the monthly variations in rainfall with the monthly fluctuations in number of specimens collected casts doubt on any direct correlation between the two. For example, the rainfall increases gradually to the March maximum, whereas there is a sharp increase in number of specimens recorded for March. Furthermore, 14 per cent of the total number of females were collected during the month with the least rainfall. The discrepancies apparent from this comparison of the monthly fluctuations in snakes recorded and the monthly rainfall record may result from the atypical distribution of the published rainfall observations, as pointed out by Dr. Bassler. The sharp increase in the number of snakes recorded in March may be closely related to the increased rainfall of March that marks the termination of what is recognized locally as the "Verano del Niño."

While the data do not lend support to a direct correlation between monthly occurrence of this snake and the monthly variation in rainfall, there are several possible indirect influences. One of these is the widespread flooding that causes concentrations on the available land. The vicinity of Iquitos is subjected to severe floods during the months of maximum rainfall, and the accompanying restriction in the land surface available may make it much easier to collect at this time than when the river is low. A study of the fluctuations of the Amazon River at Iquitos has been published by José Gonzáles Iglesias (1940). This author shows that the flood peak is

¹ The only published monthly climatic data that I have been able to locate for this locality are those reported by Knoch (1930). Unfortunately, these cover a period of less than two years and therefore may not be representative of the mean monthly variations. Dr. Bassler made careful rain gauge observations for an extended period. He informs me (*in litt.*) that the rainfall data of Knoch are not typical for the locality. He states that at Iquitos there is usually almost or quite as little rainfall during December, January, and February as there is in June, July, and August. The former months are known locally as "Verano del Niño." In March, April, and May there is somewhat more precipitation than there is in September, October, and November.

After this paper was completed Dr. Bassler was able to obtain his detailed data for the rainfall of the years 1927, 1928, and 1929, and kindly forwarded them for my use. In several instances the monthly rainfall varies considerably for the three years. Dr. Bassler states that "Twice during my residence of 10 years in Iquitos there was not any rainfall whatever in the month of February whereas in 1928, February happened to be the rainiest month of the year. In spite of this however our mean represents the picture very well." The mean monthly data for the three years are as follows (in millimeters):

Jan.	Feb.	Mar.	Apr.	May	June
160.0	203.2	266.7	276.9	261.6	147.3
July	Aug.	Sept.	Oct.	Nov.	Dec.
165.1	177.8	184.9	218.4	304.8	121.9

The relationship between the monthly rainfall and the number of snakes collected per month is less apparent from these rainfall figures for the three years recorded by Dr. Bassler. The extent of the variation in monthly rainfall observed at Iquitos indicates that the precise effect of the rainfall on the number of snakes collected can be determined only when sufficient data are available to permit a direct comparison of these two on a month by month basis.

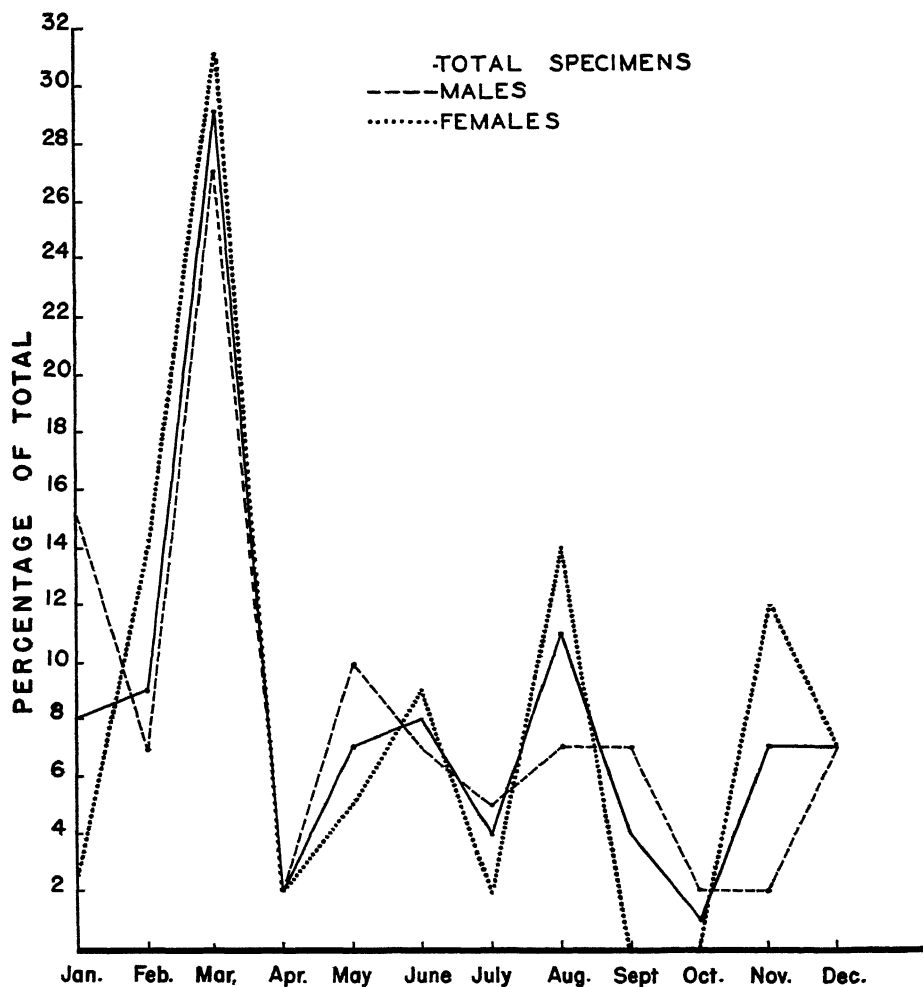


Fig. 1. Monthly variation in collections of *Thalerophis richardi nigromarginatus* in the vicinity of Iquitos, Peru.

reached in May and that the lowest level occurs in September. Neither of these extremes is correlated with unusual fluctuations in occurrence of the snakes. However, Iglesias' data show that from January through June the river is above the mean yearly level, whereas it is below this level from July to the end of December. Two-thirds of the specimens were collected during the months when the river was above the yearly mean. The high level of the river may have some influence on the occurrence of the snakes, but it cannot be either

the most important or the only factor involved. If it were the controlling factor, the peak in number of snakes should occur in May rather than in March.

Another indirect influence of the rainfall lies in the relative abundance of the animals utilized as food by *T. r. nigromarginatus*. The diet of this species is nearly restricted to frogs of the family Hylidae. These frogs are known to congregate in breeding groups during the periods of heavy rainfall, and their maximum breeding activity may reach a peak correspond-

TABLE 1

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Total specimen collected (percentage in parentheses)	38%	9 (11%)	24 (29%)	2 (2%)	6 (7%)	7 (8%)	3 (4%)	9 (11%)	3 (4%)	1 (1%)	6 (7%)	6 (7%)
Males collected (percentage in parentheses)	5%	3 (7%)	11 (27%)	1 (2%)	4 (10%)	3 (7%)	2 (5%)	3 (7%)	3 (7%)	1 (2%)	1 (2%)	3 (7%)
Females collected (percentage in parentheses)	3%	6 (14%)	13 (31%)	1 (2%)	2 (5%)	4 (9%)	1 (2%)	6 (14%)	0	0	5 (12%)	3 (7%)
Mean monthly rainfall (in millimeters)	5	269	305	167	249	186	164	115	224	181	217	286
Mean monthly temperature (in degrees Centigrade)	25.3	25.7	24.6	25.0	24.2	23.5	23.4	24.6	24.6	25.1	25.8	25.5

Total annual rainfall, 2623.0 mm.; average annual temperature, 24.8° C.

ing to the period of maximum rainfall. During the breeding period the frogs are abundant and active in the vicinity of the breeding sites. The snakes, attracted by the more plentiful food supply, are abroad in increased numbers and hence encountered more frequently by collectors. The only observations pertaining to the frogs that make up the food of these snakes are based on the examination of stomach contents. It is fortuitous whether snakes are collected immediately after eating (with identifiable stomach contents) or whether they are collected prior to eating (with an empty stomach). For months represented by six or more specimens, half of those collected in November and March and two-thirds of those collected in December contain hylid frogs. The only indication of the breeding time in the frogs serving as food is that specimens with ripe eggs have been observed in snakes collected in March and December.

Another factor that must be considered in any effort to determine the cause of the greater number of snakes taken in March is their time of mating and oviposition. No direct information is available on the breeding period of *T. r. nigromarginatus*. Figure 2 illustrates the total number of females collected per month, together with the number of females per month that possessed developing eggs. Ovarian follicles as large as 6 mm. in length were observed in immature individuals. Hence to avoid inclusion of data from females with immature eggs, a size of 10 mm. was arbitrarily selected as the minimum egg size considered. The maximum size observed was a length of 28 mm. Females with eggs 10 mm. or larger are present in snakes taken in every month except April, September, and October. No females are represented for these last two months, and only a single female is present in the April collection. Thus on the basis of these data there is no indication of a restricted breeding season. Ova approximately 25 mm. in length supposedly are close to maturity and oviposition. Eggs of this size or greater have been observed in females collected in the following months: January, March, May, June, and December.

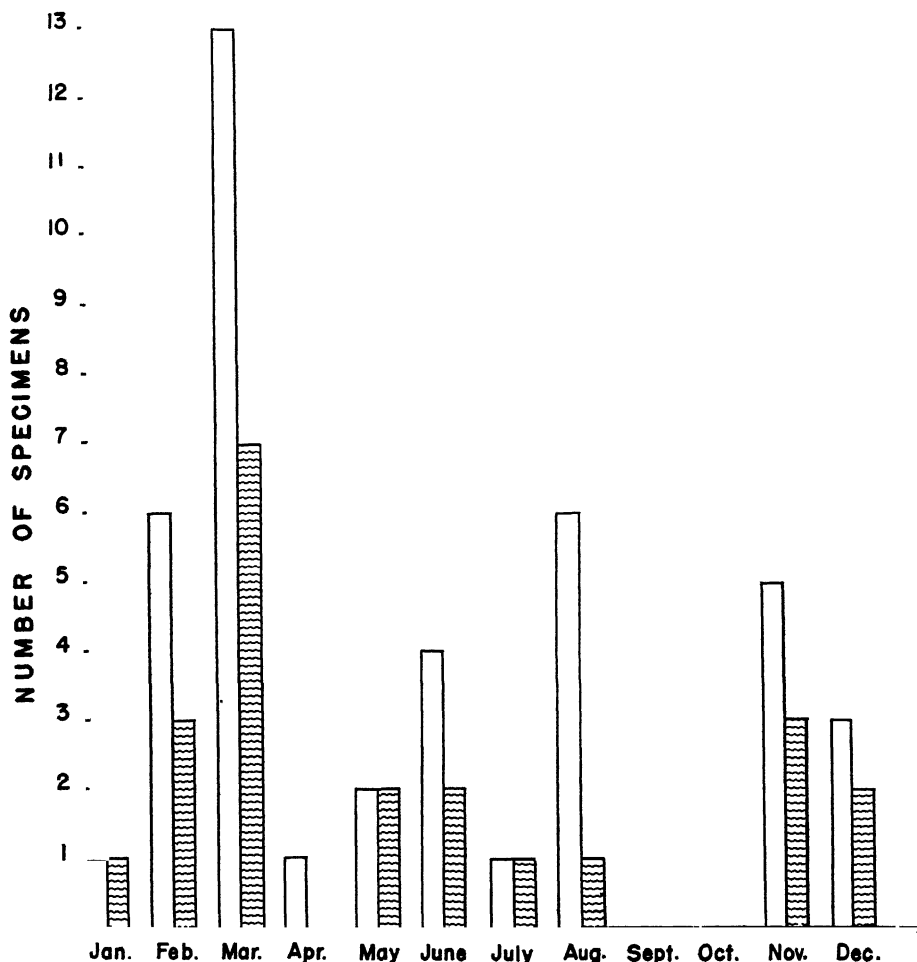


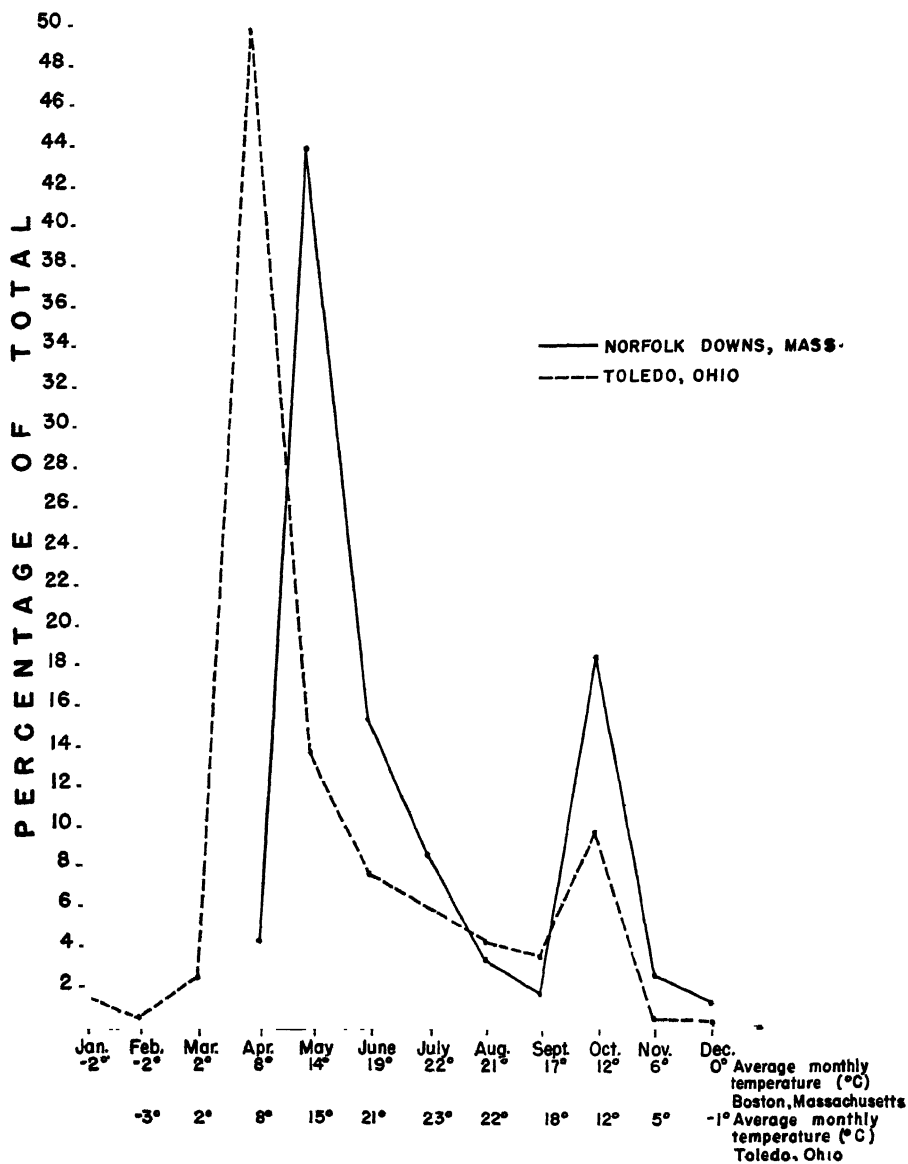
Fig. 2. Histogram showing variation in monthly collections of females (unshaded) and of females that contained developing eggs exceeding 9.9 mm. in length (shaded) of *Thalerophis richardi nigromarginatus* in the vicinity of Iquitos, Peru.

It is difficult to evaluate these few observations on reproduction because in this species little is known concerning the frequency of mating. It has not been ascertained whether a single insemination is sufficient for the fertilization of clutches over a period of years (as has been shown for other species), and the length of the gestation period, as well as the length of the post-oviposition development, is unknown. Kopstein (1938), in his study of reproduction in Javanese reptiles, noted that fewest eggs are laid in the dry months

and that "the majority of the ovipositions in Central Java are in the wet monsoons."

Kopstein's studies were made in a monsoon climate characterized by a marked dry season and a sharp increase in rainfall with the beginning of the monsoons. No similar dry season occurs at Iquitos, Peru. The lowest monthly rainfall is 115 mm. in August. Of six females collected during that month, none has any eggs larger than 10 mm. in length. This may be an indication that here, too, fewer eggs are produced in the months of less rainfall, but

DIAGRAM A



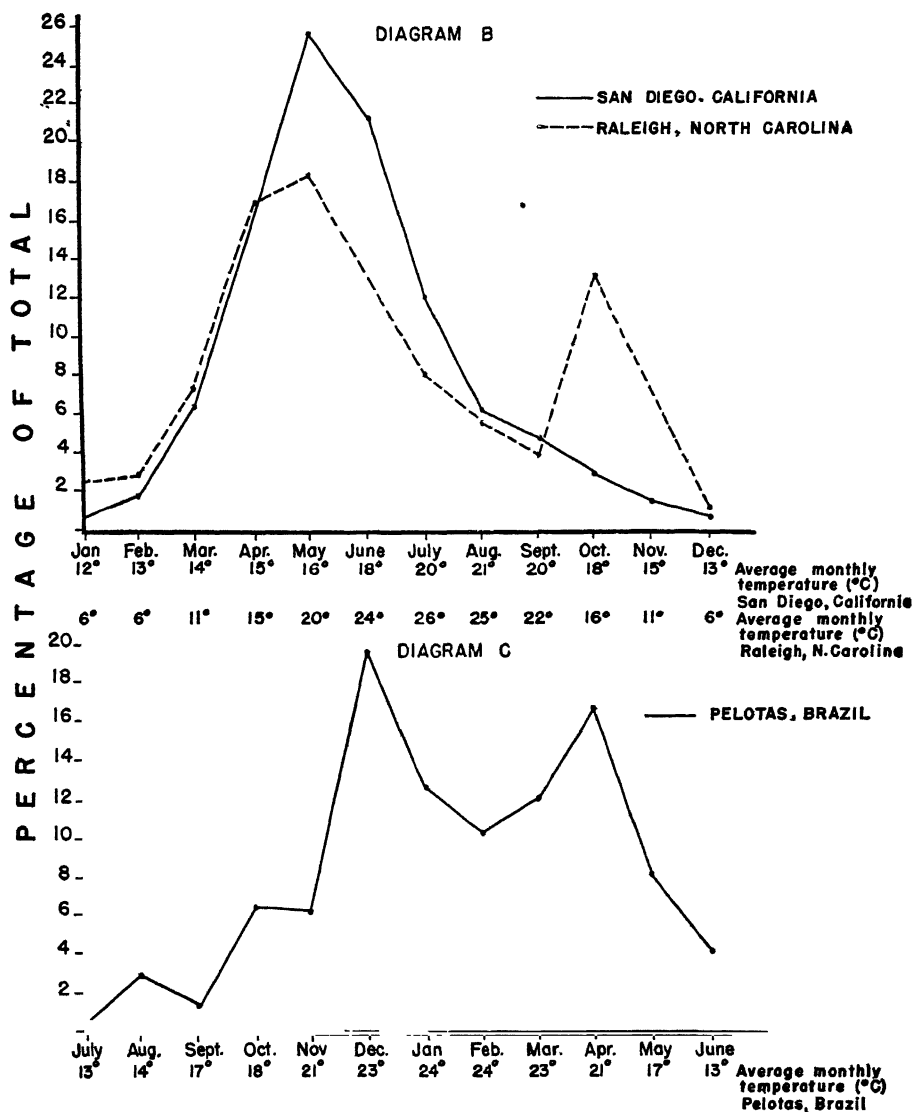


Fig. 3 (this page and opposite). Diagrams illustrating the seasonal incidence of snakes at five different geographical localities, with mean monthly temperatures for each location. Note that in diagram C the months are arranged in sequence beginning with July since this locality is in the Southern Hemisphere.

the data are too limited to establish this. For the series of *nigromarginatus* no marked monthly restriction either of mating or of oviposition that might result in pronounced peaks of occurrence is indicated, although periodic variation in the frequency of these activities doubtless exists.

An inherent physiological cycle of activity conceivably might be a factor reflected in the seasonal incidence. The genus is derived from racer-like colubrine stock, the ancestors of which were presumably evolved in North America. As pointed out below, all of the studies dealing with northern temperate forms illustrate a major peak in the spring months, but not so

early as March. There is little evidence to support the view that the March peak in *nigromarginatus* is due to any ancestral physiological trait.

Finally a potential influence is that of human activity. It might be demonstrable that more men were engaged in collecting during the time when the major peak was attained, or that collecting activities varied sufficiently during that time to expose greater numbers of the snakes. Concerning these possibilities I have the statement of Dr. Bassler who believes that there was no variation in human activity that could explain this peak.

REVIEW OF PUBLISHED DATA

In order to analyze the data for *nigromarginatus*, it is instructive to compare them with the observations available in the literature. There are numerous references to the more prominent aspects of the seasonal fluctuations of snakes. These are usually incidental to other subject matter, but they may constitute the central theme of a particular article on hibernation (Ruthling, 1915; Werner, 1927) or on estimation (Werner, 1891; Schmalz, 1911). Only a few authors have presented data covering the entire period of activity in the area where the observations were made. Because of the limitations in such data, only crude comparisons can be made, and only the broader trends can be noted.

The most detailed and prolonged observations are those of Klauber (especially 1924, 1926, 1931, and 1939) on species of the arid southwestern United States, mainly San Diego County, California. Similar studies on a smaller scale have been reported for other parts of the United States by Brimley (1925), by Conant (1938), and by Loveridge (1927). Volsøe's (1944) detailed comments on the seasonal incidence of *Vipera berus* in Denmark are included as part of his thorough study of the male reproductive organs in that species. Since his data include large numbers of specimens dug out of hibernation dens, the figures for monthly percentages are not comparable to those of the pre-

ceding authors. Lindberg (1932) supplies data for the monthly distribution of 434 specimens, representing 19 species, killed between August 19, 1929, and November 1, 1931, along a 203-mile stretch of railroad in India. This railroad is situated on the southwestern section of the Deccan Plateau and includes altitudes between 1600 and 2200 feet above sea level. Consequently marked differences in climatic conditions might occur in various portions of the area involved. Magalhães (1922) records the number of venomous snakes sent to the Instituto de Hygiene at Pelotas, Rio Grande do Sul, Brazil, between March, 1918, and May, 1921. The vast majority of these snakes probably came from the vicinity of Pelotas.

The data presented by these authors, with the exception of those recorded by Lindberg (*op. cit.*) and Volsøe (*op. cit.*), are shown graphically in figure 3. The data presented by Loveridge (*op. cit.*) are included for comparative purposes, although they do not cover the entire year. In diagram C of this figure the months are arranged in sequence beginning with July rather than January in order to make the data from this locality in the Southern Hemisphere more readily comparable to those from the other areas by placing the warmer months for all regions in the same relative positions on the graphs.

The presentation of these data in three

separate diagrams facilitates comparison of them and permits a grouping of the data according to localities within similar major climatic categories.¹ The data in diagram A represent localities possessing "Humid Continental Climates," whereas those in diagrams B and C represent localities having "Subtropical Climates." Blair's (*op. cit.*) definitions of the climate of each locality are given below in abbreviated form and with temperatures and rainfall expressed in metric equivalents of the original.

Toledo, Ohio: WARM HUMID CONTINENTAL CLIMATE

Mean temperatures: coldest month below 6° C.; none to three months below 0° C.; six to nine months above 10° C. Growing season 140 to 220 days; rainfall mostly between 508 and 1016 mm. with summer maximum.

Norfolk Downs, Massachusetts: MODIFIED HUMID CONTINENTAL CLIMATE

Some marine influence; colder summers and less severe winters; mean temperature of five to seven months above 10° C.; none to four months below 0° C.; fairly even distribution of precipitation through the year, with heavy winter snows.

Raleigh, North Carolina: HUMID SUBTROPICAL CLIMATE

Pelotas, Brazil: HUMID SUBTROPICAL CLIMATE

Rainfall moderate to heavy with rain at all seasons, usually a maximum in summer; mean temperature of coldest month above 6° C. but below 18° C.; nine to 12 months above 10° C.; occasional freezing temperatures; growing season 220 days or more.

San Diego, California: DRY SUBTROPICAL (MEDITERRANEAN) CLIMATE

Subhumid; annual rainfall typically between 508 and 762 mm. but some areas have less than 508 mm. and a few more than 762 mm. A distinguishing characteristic is that the maximum rainfall is in winter; the summers are dry, often rainless for two or three months; rainfall is cyclonic; mean temperature of coldest month above 6° C. but below 18° C.; freezing temperatures occur some years but growth is normally continuous; hot summers, mild winters, high percentage of sunshine.

Figure 3 reveals similarities as well as

differences between the profiles of monthly incidence for the localities shown. In all of the graphs there is a period of low incidence during the colder months of the year when the snakes customarily are in hibernation. This period is followed by a sharp increase in numbers during the spring months when the temperatures have risen sufficiently to permit emergence from hibernation. This marked increase is termed the spring peak of abundance. Then there is an almost equally sharp decline as the monthly temperatures increase, and in four of the five sets of data there is a smaller secondary increase in the fall.

Differences are to be noted in the nature of the peaks in the spring, especially in the suddenness of the increase, its duration, and in the slope of the decline. Additional differences may occur in the presence or absence of a peak of abundance in the fall and in the extent of the decrease during the warm weather.

At Norfolk Downs and Toledo, the two localities with the shortest growing season and with the greatest annual range in temperature, the spring peaks are extremely sharp and of short duration, with more than 40 per cent of the annual total recorded in a single month. The decline of the spring peak is not quite so abrupt as its appearance. The minor peaks in the fall are equally short in duration and as sharp in outline as those of spring, but of much less prominence. The three subtropical climates exhibit more gradual, lower, and more prolonged spring peaks than those of the colder climates. The graph of the data from San Diego illustrates the highest spring peak of these three, and is the only one that shows no secondary peak in the fall months for the data covering all species. The decline in numbers during the warmer months is less pronounced at Pelotas than at any other locality and the two peaks are almost equal in size.

DISCUSSION

Numerous factors contributing to the fluctuations in numbers of specimens have

been listed. Temperature appears to be the most important single environmental factor limiting the activities of the ectothermal animals under consideration, for

¹ For this purpose the climatic classification of Blair (1942) has been employed.

each species can be active only within a particular range of temperatures. When body temperatures drop below this range hibernation is imperative if death is to be avoided. Similarly, temperatures above the maximum tolerated bring about estivation in protected situations. Within the range of compatible temperatures other environmental factors may become effective. But it is primarily the decrease in the temperatures of the air and the substratum, as well as the available solar heat, that produces the low incidence of snakes during the colder months of the year. The length of the hibernation period depends upon the prevalence of low temperatures, and its termination depends upon a sufficient rise in the thermal level to permit the snakes to become active.

Volsøe (*op. cit.*) has carefully analyzed the factors influencing hibernation in *Vipera berus* in Denmark. He states, "Probably no single climatic component is responsible for the duration of the hibernation, but rather the combined action of several factors. The maximum temperature of the day and the daily duration of the sunshine are the factors which first suggest themselves. In the years 1937 to 1942 the first appearance of the Vipers in the spring took place on the first sunny days after the maximum [air] temperature had reached 8° C." Concerning the onset of hibernation in the fall, this same author observes, "that hibernation begins at about the same temperature conditions which terminate it in the spring, i.e., when the maximum temperature of the day sinks below about 8° C., or perhaps earlier, at about 9°-10°, owing to the cloudy weather which prevails in the autumn."

The termination and onset of hibernation will vary slightly for different species, depending in large measure on the temperature preferences of the species involved. This species difference doubtless affects the occurrence of the spring peak. Brimley (*op. cit.*), Conant (*op. cit.*), Klauber (1931), and Herter (1940) have pointed out that there are "early" and "late" species on the basis of their activity.

Whereas the temperature of the environment, with all its complexities, appears to

be the controlling factor in terminating hibernation, numerous phenomena contribute to the formation of the spring peaks. These possibly include the following: basking in the sun during the spring, frequently in aggregations around denning sites in the case of those species that hibernate in groups; mating activity, which occurs at this time in most species; increased appetite for food following hibernation; lack of adequate cover because of incomplete development of foliage; and an increase in human activity with the result that more snakes are seen or collected. The phenomena listed are in themselves dependent in large measure upon the influence of temperature. It is highly significant, as pointed out by Conant (*op. cit.*), that the spring and fall peaks occur at nearly the same average monthly temperature. In the four sets of data that indicate a peak in the fall the difference in mean average monthly temperatures between the month of the spring peak and of the fall peak is 2° to 4° C.

The mean temperatures recorded for months during which the spring peaks occur vary from 8° to 23° C. The two lowest temperatures occur at the localities in the colder climatic types, whereas the maximum temperature occurs at the locality having the highest annual temperature. The effect of rainfall varies with the temperature prevailing at the time of the rain. For example, Conant (*op. cit.*) and Klauber (1931) have noted that rain has a detrimental effect in the early spring when temperatures are near the minimum for a snake's activity, primarily owing to the accompanying drop of the air and ground temperatures. On the other hand, summer and fall rains seem essential in preventing or terminating summer drought, or in lowering excessively high temperatures that result in poor snake collecting. Moreover, the clouds accompanying the rains may reduce solar radiation sufficiently to permit some species to emerge. The data reported by Lindberg (*op. cit.*) indicate a marked increase in the number of snakes following the onset of the rains accompanying the monsoons. Keays (1930) states that pythons appear each

year in considerable numbers in India during the rainy season and disappear at the end of the monsoons.

The decrease in the number of specimens following the peak of the spring months may be due in part to the rise in temperatures during the summer months. However, the lowest numbers of snakes are recorded after, and not coincidental with, the highest monthly temperature, but this may be due to the lag in substratum temperatures. Klauber has shown definitely that temperature alone does not cause the decrease in San Diego County. Additional factors that may contribute to the reduction in numbers observed are: (1) satisfaction of the increased requirements of food following hibernation; (2) completion of mating activities; (3) increased solar heat and its deterrent effect on prolonged basking; (4) change from diurnal to crepuscular or nocturnal habits; (5) increase in protective cover with fully developed foliage on plants; and (6) estivation during periods of high temperatures and low relative humidity. Klauber has observed a difference between the sexes in seasonal activity, with males predominating in most rattlesnake collections, except those made just prior to hibernation at which time the sexes were equal. He suggests that the males range abroad more carelessly and that probably the females remain in concealment when heavy with eggs. Volsø (*op. cit.*) records a predominance of female *Vipera berus* for the months of May through September, although predominance of males in the spring and fall is sufficient to give a slightly greater number of males than females for the yearly total.

In the studies made in the northern latitudes the minor secondary peak in the fall seems to be due to the recurrence of temperatures similar to those recorded during the time of the spring peak. Additional factors that may influence the increase in numbers recorded in the fall are: (1) the return to the dens in the case of those species that hibernate in groups; (2) decrease in effective solar heat, with a resumption of basking; (3) fall mating in a few species; and (4) the appearance of the

young of the year. The only study in which a fall peak was not observed is that made by Klauber (*op. cit.*). Although there is no fall peak in his study for the graph showing all species, there is a secondary fall peak in a few species in the San Diego County region. Concerning this, Klauber states, "For all species combined this secondary peak appears rather as a leveling out of the curve before the decline to the minimum in winter."

One of the drawbacks in this review of published studies for comparative purposes lies in the fact that the data considered are for all species at a given locality. Where data are available for individual species, differences apparently do exist between species. As mentioned above, "early" and "late" species have been distinguished on the basis of a difference in seasonal incidence, and Klauber's graph (1931, fig. 1) shows differences in the curves even though peaks for various species occur in the same month. There is a great need for detailed data pertaining to individual species at different geographical localities throughout the species range. It might be desirable to compare the data for *Thalerophis richardi nigromarginatus* with those derived from the most closely related species from each locality. This method was tested, and the results do not differ appreciably from those where all species were included. In other words, the relative frequencies of occurrence of species most closely related to *Thalerophis* conform to the average for a given locality. One graph, based on the data from Pelotas, Brazil, illustrates the incidence of venomous species only, and may depict a situation somewhat different from that for the total species at that locality.

In this connection, it is worth while to graph the data for the monthly occurrence of venomous snake bites in the United States published by Hutchison (1929, 1930). The results are shown in figure 4. It is highly interesting to note that the maximum number of snake bites occurs at a later date than the maximum number of snakes in the other graphs; it actually occurs when those numbers are decreasing. This difference might be attributed to sev-

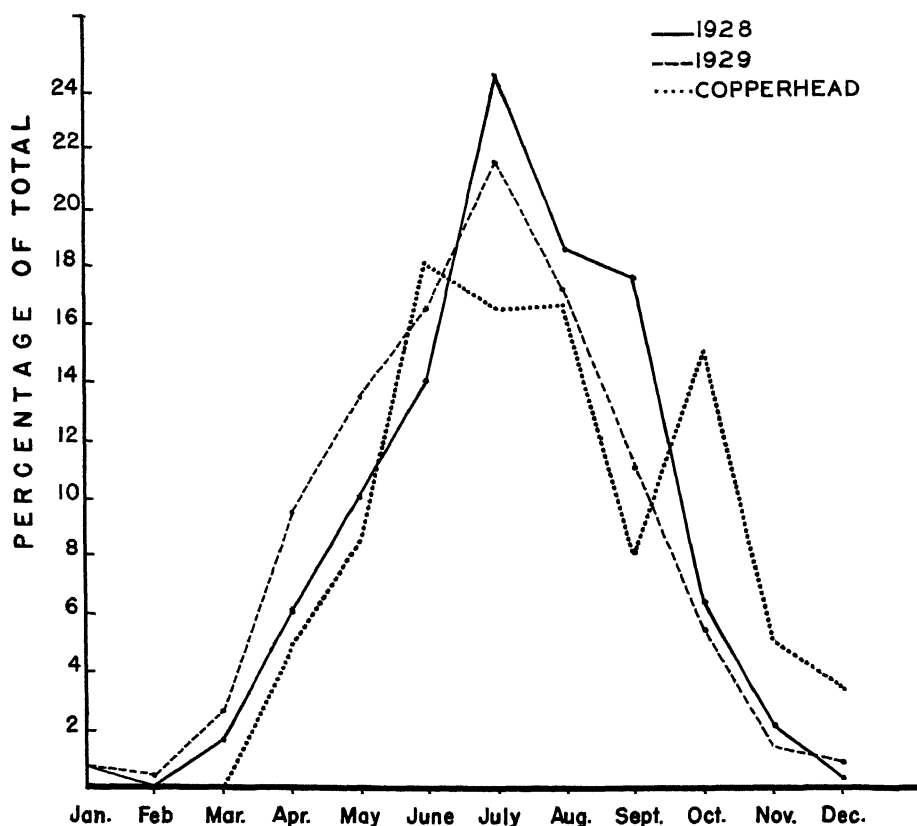


Fig. 4. The monthly occurrence of snake bites recorded in the United States for a two-year period, 1928 and 1929, and the seasonal incidence of the copperhead in the vicinity of Raleigh, North Carolina.

eral factors. Hutchison (1930), discussing the seasonal distribution of the bites, says only that "the information there given is very similar to that for 1928 and emphasizes the relation between temperature and the activity of these Ophidia." The occurrence of the bites suggests strongly that the increased outdoor activity on the part of humans during the summer months is an important factor.

Hutchison points out that the data dealing with the seasonal incidence of snake bites suggest specific differences in regard to the species responsible for the bites. The copperhead (*Agkistrodon mokeson* subsp.) was responsible for more bites than any other single species during the two years under consideration. The only data

available for the seasonal incidence of this snake are from Raleigh, North Carolina, and these have been plotted on figure 4. For such a crude comparison there is a surprising degree of similarity between the incidence of this snake in North Carolina and the seasonal occurrence of snake bites. The graph illustrating the seasonal incidence of the copperhead in the vicinity of Raleigh, North Carolina, is also quite similar to that for the pit vipers at Pelotas, Brazil, two localities with the same climatic classification.

Comparison of the graph for the copperhead with that for the total species observed at Raleigh shows that this snake is most abundant one month later than the average peak for all species and that it re-

mains active during the period of decreased activity for the other species in that locality. Conant (*op. cit.*) found that the massasauga (*Sistrurus c. catenatus*) became active later than the other species at Toledo, Ohio. Two of the three species of rattlesnakes studied by Klauber (1931) were found to be active early, whereas the third was late. The data for the venomous species at Pelotas, Brazil, suggest that they

may represent late species to judge by the monthly temperature changes. These species also maintain a relatively high incidence throughout the warm months. All of the venomous species mentioned above are crotalids, and they are mainly crepuscular or nocturnal in habits during the warmer periods. These habits may explain in part their departure from the incidence exhibited by the non-venomous species.

SUMMARY AND CONCLUSIONS

Data dealing with the seasonal incidence of a Neotropical colubrine snake, *Thalerophis richardi nigromarginatus*, are presented. In the vicinity of Iquitos, Peru, these snakes exhibit a peak of maximum abundance in March, at which time 29 per cent of the total number are recorded. Analysis of monthly fluctuations in numbers suggests that climatic as well as other factors influence the activities of these snakes. The slight variation in mean monthly temperatures, with a range of only 2.4° C., indicates that thermal factors are not the basic cause for the fluctuations.

Rainfall appears to be the most important physical factor influencing the activities of these snakes, although its action is primarily indirect. Two phenomena associated with rainfall and affecting the incidence of the snakes are (1) the abundance of the frogs that constitute their principal food, and (2) the restriction of the dry land areas as a result of widespread flooding during the wet months of the year.

In contrast to the observations on *Thalerophis* are those reported for snakes at localities in the higher latitudes where there are marked variations in monthly temperatures. The extreme fluctuations in temperature bring about a decrease in the incidence of snakes, resulting either in hibernation when the temperatures are low or in estivation when they are high. The studies referred to illustrate a maximum abundance in the spring of the year

as soon as hibernation is terminated. This is followed by an almost equally sharp decline in numbers during the warmer, and frequently drier, months. In four of the five studies a small peak of abundance occurs in the fall when the temperatures again approach those prevailing at the time of the spring peak.

Within the limits of the controlling temperatures various factors may influence the monthly fluctuations: (1) aggregation of some species in the vicinity of hibernation dens; (2) mating activity; (3) increased appetite for food following hibernation, and a later decrease in appetite; (4) basking during periods of near-minimal air temperatures; (5) variations in the amount of protective cover provided by deciduous vegetation; (6) change from diurnal to crepuscular or nocturnal habits with an increase in diurnal temperatures; (7) rainfall; (8) seasonal variations in human activity; (9) oviposition; and (10) the appearance of the young of the year.

The monthly maximum for snake bites recorded in the United States occurs from two to three months later than the period of maximum incidence reported at the four localities in the United States. This discrepancy probably can be attributed to the later appearance and more prolonged summer activity of the venomous species responsible for most of the bites, as well as to the increased outdoor activity of humans during the summer months.

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THE SYRPHIDAE OF GUADALCANAL, WITH NOTES ON RELATED SPECIES

By C. H. CURRAN

Most of the material reported upon in this paper was collected in Guadalcanal Island by Mr. C. O. Berg, who also had an opportunity to study the biology of several of the species. It is his intention to report upon his observations in the near future. Of the 28 species contained in the collection, 10 are described for the first time.

The Museum is greatly indebted to Mr. Berg for the generous donation of types and uniques not represented in its collection. Where no collector's name is cited under the records of previously described species, the material was collected by Mr. Berg. The names of other collectors are included in the data, and we wish to express our appreciation to them for the donation of the recorded specimens as well as of many other insects of various orders.

MICRODON MEIGEN

This genus is represented by a single, undescribed species. In order to show its relationship to other species of the Indo-Australian region, I present a key to the species I have seen:

TABLE OF SPECIES

- | | | | |
|---|----|---|----|
| 1. Scutellum with spines or strong marginal swellings or at least deeply emarginate apically..... | 2 | 4. Antennae longer than the head..... | 5 |
| Scutellum almost evenly convex... | 18 | Antennae shorter than the head..... | |
| 2. Scutellar spines or tubercles closer together than the length of the scutellum, which is about as long as wide..... | 3 | <i>minuticornis</i> Curran | |
| Scutellum almost or quite twice as wide as long, its apex gently concave between the spines which arise from the corners..... | 10 | 5. Face wholly black or brown..... | |
| 3. Tibiae white or yellow pilose above on most of their length..... | 7 | <i>laxiceps</i> Curran | |
| Tibiae black haired above except at extreme base..... | 4 | Face at least broadly reddish laterally..... | 6 |
| | | 6. Face bright yellow pilose and mostly reddish yellow..... | |
| | | <i>dimidiatus</i> Curran | |
| | | Face black pilose; brown in the middle and above..... | |
| | | <i>pagdeni</i> Curran | |
| | | 7. Wings cinereous hyaline, the cross veins sometimes clouded with brown..... | 8 |
| | | Wings broadly brown in front, hyaline behind..... | |
| | | <i>robinsoni</i> Curran | |
| | | 8. Abdomen narrowest at the second segment..... | |
| | | <i>luxor</i> Curran | |
| | | Abdomen widest at second segment..... | 9 |
| | | 9. Mesonotum with transverse brassy yellow fasciae..... | |
| | | <i>klossi</i> Curran | |
| | | Mesonotum with unicolorous pile..... | |
| | | <i>trimacula</i> Curran | |
| | | 10. Face wholly white, yellowish, or tawny pilose..... | 12 |
| | | Face largely or wholly black pilose..... | 11 |
| | | 11. Face wholly black pilose..... | |
| | | <i>lativentris</i> de Meijere | |
| | | Face yellow pilose laterally; wings pale yellow in front..... | |
| | | <i>grandis</i> Curran | |
| | | 12. Mesonotum and scutellum wholly tawny or golden yellow pilose.... | 13 |
| | | Mesonotum mostly black pilose, the sides sometimes with white hair.. | 14 |
| | | 13. Legs black pilose..... | 17 |
| | | Femora and tibiae tawny pilose..... | |
| | | <i>baramus</i> Curran | |
| | | 14. Abdomen with white or yellowish pilose areas..... | 15 |
| | | Abdomen wholly black haired..... | |
| | | <i>stilboides</i> Walker | |

15. Anterior four tibiae and scutellum
wholly white pilose.....
..... *alboscutatus* Curran
Tibiae and scutellum black pilose.. 16
16. Face white pilose.....
..... *latiscutellaris* Curran
Face tawny pilose..... *beatus* Curran
17. Abdomen reddish beyond the second
segment; pleural pile yellow in
front..... *lundura* Curran
Abdomen green, the male genitalia
reddish; pleural pile wholly black
..... *aeneoviridis* Curran
18. Color bright metallic blue.....
..... *sumatranus* Wulp
Color not bright metallic blue..... 19
19. Abdomen wholly red, wider than the
thorax; wings almost uniformly
brown..... *rufiventris* Curran
Abdomen not wholly red, or if so, the
wings with contrasting colors... 20
20. Wings black basally, pale orange on
more than the apical half.....
..... *pretiosa* Curran
Wings differently colored..... 21
21. Antennae shorter than the head... 28
Antennae longer than the head.... 22
22. Wings whitish with brown apical spot
..... *pendleburyi* Curran
Wings not whitish, if with brown
apical spot, the marginal cell is al-
most all brown..... 23
23. Wings with brown spots occupying
the apical fourth, the marginal cell
mostly brown..... *wulpi* Mik
Wings differently colored..... 24
24. Legs wholly black or brown in ground
color..... *stenogaster* Curran
Legs with extensive yellowish or red-
dish areas..... 25
25. Wings with transverse brownish
markings on the cross veins.....
..... *klossi* Curran
Wings almost uniformly brownish.. 26
26. Second and third abdominal seg-
ments mostly yellowish.....
..... *auroscutatus variventris* Curran
Abdomen practically all dark..... 27
27. Short, compact species.....
..... *fulvipes* de Meijere
More elongate, moderately slender
species..... *auroscutatus* Curran
28. Face and mesonotum golden yellow

pilose..... *minuticornis* Curran
Face and mesonotum black pilose....
..... *boharti*, new species

Microdon boharti, new species

Deep blue black, face and mesonotum black pilose; wings brownish on apical half; scutellum unarmed. Length, 10 mm.

FEMALE: Face narrow, the front gently narrowing to the vertex, the frontal depression at the middle of the front very broad and shallow; ocellar triangle scarcely longer than wide, the ocelli situated far forward. Occiput grayish pollinose. Face considerably receding below, rather strongly convex on the lower half, weakly so above. Pile black, whitish on the occiput. Antennae black, decidedly shorter than the length of the head, the first and third segments of about equal length, the third elongate oval, the upper edge very slightly convex, the apex obtusely pointed above; hair black; arista brownish red, reaching to beyond the tip of the third segment. Eyes bare.

Thorax black, the pleura mostly, and the posterior calli, brownish. Pile short, appressed, black; in front there is some fine, erect pale hair, and there is a patch of whitish hair on the pteropleura. Scutellum rather strongly metallic blue, the hair short and black.

Legs black, with short, appressed black hair. Wings cinereous hyaline basally, the apical half smoky brown; apical cross vein transverse, carried slightly outward in front; vein closing the discal cell bulbous behind, and recurrent anteriorly. Squamae luteous, with yellow fringe, the upper lobe with brown border and fringe.

Abdomen bluish black, with short, appressed black hair; first segment, basal lateral triangles on the second, broad, transverse apical spots on the sides of the third and fourth segments, and a small spot on the apical angles of the fifth segment white haired. Venter brownish and white pilose basally, otherwise black and black haired. The abdomen is widest at the apex of the second segment, with subparallel sides, the fifth segment strongly narrowing to the apex.

HOLOTYPE: Female, Guadalcanal, April, 1945 (G. E. Bohart).

The abdomen is somewhat crushed so it is possible that it may be somewhat oval.

Citabaena peltata de Meijere

Eumerus peltatus DE MEIJERE, 1908, Tijdschr. v. Ent., vol. 51, p. 223.

One female, Guadalcanal, February, 1945.

This belongs to the group in which the hind tarsi are broadened and flattened.

Ornidia obesa Fabricius

Syrphus obesus FABRICIUS, 1775, Systema entomologiae, p. 763.

Seven males and 18 females, Guadalcanal, August and September, 1944, and April 19, 1945 (C. O. Berg), and female, July 23, 1945 (Frank Cilley).

This species has been recorded from a number of the islands of the Pacific and is common throughout the American tropics.

Syrphus contax, new species

Face and cheeks yellow; mesopleura partly yellow; legs wholly yellowish; abdominal segments with two narrow black fasciae. Length, 9 mm.

MALE: Frontal triangle black, reddish yellow in front, the black area thickly covered with ochraceous pollen except anteriorly; a black spot above each antenna; pile black, some pale hairs along the orbits. Vertical triangle small, black, thinly brownish pollinose except in front, the hair black. Occiput cinereous pollinose, the orbits more or less brassy, the pile brassy yellow, becoming white below. Face and cheeks yellow, the face, except the moderately large tubercle, yellow pollinose, in profile gently concave above, very narrowly concave below the tubercle; pile yellow.

Thorax black, the notopleura and the broad posterior border of the mesopleura apparently luteous in ground color but densely clothed with tawny yellow pollen, the pollen otherwise cinereous yellow. The mesonotum is bronze black, the sides very broadly pale pollinose in front, and a pair of broad, pollinose stripes extend from the

anterior margin to behind the middle. Pile bright golden yellow. Scutellum yellow, rather dull, with yellow pile, the apex with black hair.

Legs wholly reddish yellow and with yellow hair, the broad apex of the hind femora and their tibiae and tarsi with short black hair. Coxae aeneous brown, the front pair mostly yellow.

Wings hyaline, the stigmal cell pale brownish. Squamae and halteres reddish yellow.

Abdomen pale orange, the base, lateral margins, and very broad basal bands on the second to fourth segments shining, with six narrow black bands, those on the apices of the segments extending over the side margins, the others well separated from them. The anterior bands are situated at about the basal fourth of the second to fourth segments; those on the third and fourth segments interrupted in the middle and slightly tapering to the sides; that on the second produced posteriorly near the middle and carried obliquely forward to unite at the basal fifth of the segment. The black posterior band on the second segment encloses a narrow, preapical fascia on the median half, the band on the third segment is similar, but the pale fascia extends across the median two-thirds of the segment. On the fourth segment the posterior yellow band is much wider in the middle than the black one and tapers to the sides, the apex of the segment very narrowly brown. The base of the abdomen is semitranslucent except laterally, and the bases of the segments are grayish white pollinose when viewed from certain angles. Pile subappressed, black; mostly yellow and erect on the two basal segments. Genitalia shining brown posteriorly. Venter reddish yellow, the second and third sternites with preapical brown fascia; hair yellow, black on the fourth sternite except basally.

HOLOTYPE: Male, Guadalcanal, August, 1944 (C. O. Berg).

In form, this species is very similar to the species described by de Meijere as *elongatus*, but the abdominal markings are quite different. Both these species are referable to the *balteatus* group.

Syrphus demeijerei, new name

Syrphus elongatus DE MEIJERE, 1908, Tijdschr. v. Ent., vol. 51, p. 309 (not Fabricius, 1775).

This species is described and the abdomen illustrated in the reference cited above.

Asarkina salviae Fabricius

Syrphus salviae FABRICIUS, 1787, Mantissa insectorum, vol. 2, p. 340.

A single female from Guadalcanal, August, 1944.

Asarkina eurytaeniata Bezzi

Asarkina eurytaeniata BEZZI, 1908, Ann. Hist.-Nat. Mus. Natl. Hungarici, vol. 6, p. 497.

One male and three females, Guadalcanal, December, 1944, and February and April, 1945.

Asarkina hemipennis Hull

Dideopsis hemipennis HULL, 1946 (description not seen).

Seven males and one female, Guadalcanal, September and November, 1944, and March, 1945 (C. O. Berg); male and female, Oro Bay, New Guinea, November-December, 1944 (B. Struck).

There is no doubt that this species is distinct from *aegrota* Fabricius, and it seems likely that it is different from *pura* Curran, from Selangor. The color of the wings is similar.

Sphaerophoria javana Wiedemann

Syrphus javanus WIEDEMANN, 1824, *Analecta entomologica*, p. 34.

One female, Guadalcanal, July, 1944.

This species bears a strong resemblance to *Ischiodon scutellaris* Fabricius but is readily distinguished by the shape of the third antennal segment.

Ischiodon scutellaris Fabricius

Saeva scutellare FABRICIUS, 1805, *Systema antliatorum*, p. 252.

Three males and six females, Guadalcanal, August to October, 1944, and January and February, 1945.

Widely distributed over the Indo-Australian region. *I. aegypti* Wiedemann is from Africa and differs in many respects.

BACCHA FABRICIUS

This is a large genus and contains many groups in which there is rather similar coloration, the ready separation of the species depending upon other characters, especially the male genitalia and color of pile. I have enlarged my most recent key to the Malayan species to include all the species from the Indo-Australian region of which I have specimens. Unfortunately, it is not possible to include other described species since important characters are not mentioned in the descriptions.

TABLE OF SPECIES

1. Scutellum wholly or partly yellow... 2
Scutellum wholly blackish..... 18
2. Face with a median black stripe.... 3
Face wholly yellowish or reddish.... 8
3. Wings with a broad, brownish median band..... 4
Wings brown only along the costal border..... 5
4. Scutellum wholly pale; humeri with row of hairs behind.....
..... *mundulosa*, new species
Scutellum black with pale yellow base and border; humeri bare.....
..... *dispar* Walker
5. Abdomen reddish with three broad, transverse black fasciae.....
..... *amphithoe* Walker
Abdomen much more extensively black..... 6
6. Alula almost linear, very narrow; ventral scutellar fringe absent; squamal fringe inconspicuous.... 7
Alula of moderate width; ventral scutellar fringe yellow; squamal fringe yellow, well developed.....
..... *pedicellata* Doleschall
7. Costal border of wings almost evenly brown from base to apex (Selangor).....
..... *nigrapex* Curran
Costal border pale basally, the brown forming an apical spot.....
..... *triangulifera* Austen
8. Legs entirely reddish..... 9
Legs in part black or brown..... 14
9. Alula entirely rudimentary.....
..... *pallida* de Meijere
Alula moderately narrow but not linear..... 10

10. Thorax rather dark rusty reddish with the yellow spots in strong contrast *vespaeformis* Doleschall
Thorax rusty yellowish without contrasting yellow spots.....11
11. Mesonotum with a pair of brown lines on the anterior half, male.....
..... *bergi*, new species
Mesonotum without dark vittae...12
12. Costal brown border of the wings expanded to form a spot extending over the basal cross veins, female..
..... *bergi*, new species
Brown costal border not expanded...13
13. Disc of mesonotum with small, transverse shining black spot.....
..... *perpallida*, new species
Mesonotum wholly pale. *rubella* Wulp
14. Wings dark only in front.....15
Wings wholly brown, darker in front.....
..... *virtuosa* Curran
15. Fourth abdominal segment not wholly black.....16
Fourth abdominal segment wholly black..... *macgregori* Curran
16. Costal border brown on the whole length; scutellum wholly pale.....
..... *gigas* Curran
Costal border not brown on the whole length; scutellum with black spot.....17
17. Third abdominal segment with very broad, entire yellowish fascia.....
..... *tinctiventris* de Meijere
Third abdominal segment with a pair of elongate, longitudinally placed yellowish spots.....
..... *luteolimbata* de Meijere
18. Sides of the face broadly yellowish in ground color on more than the upper half.....19
Sides of face black in ground color on more than the upper half.....21
19. Wings with the alula of full size.....
..... *pulchrifrons* Austen
Alula distinctly narrowed.....20
20. The yellow of the sides of the thorax is wholly limited to the notopleura.....
..... *porphyra* Curran
The yellow color extends onto the surrounding parts in front of the suture..... *fallax* Austen?
21. Wings with narrow, conspicuous clouds on the cross veins.....
..... *maculata* Walker
Cross veins at middle of wing not conspicuously clouded.....22
22. Humeri haired posteriorly.....23
Humeri not haired posteriorly.....
..... *varipes* Curran
23. Wings with small apical brown spot..
..... *nigricoxa* Curran
Wings hyaline, the stigma brown.....
..... *chalybescens* Curran

***Baccha mundulosa*, new species**

Blackish, base of abdomen reddish, the third segment with arched reddish fascia; wings with the costal brown border greatly expanded before the middle. Length, 14 mm.

MALE: Facial stripe, front, and vertical triangle shining black, the upper third of the frontal triangle densely grayish brown pollinose. Ocellar triangle small, situated far forward. Occiput and posterior part of the cheeks black, cinereous pollinose. Face reddish, cinereous pollinose on the lower orbits and beneath the antennae, black stripe narrowing below and not quite reaching the oral margin; tubercle narrow and small, the face not receding below. Antennae reddish, the arista brown on the apical half or more. The pile is black on the front and upper angles of the face, otherwise brassy yellow.

Thorax black, the pleura aeneous in front and behind, brown below the wings, the sides of the mesonotum in front of the suture and a broad band extending downward onto the sternopleura reddish in ground color and with thick cinereous pollen, the aeneous areas with thin pollen; sides of mesonotum behind the wings and the scutellum brownish red. Mesonotum in front of the suture somewhat dulled by brownish pollen; pile brassy yellow, black behind the suture and rather dense laterally; scutellar pile brassy yellow and moderately long. Humeri with a single transverse row of yellow hairs, the collar moderately strong.

Legs reddish; posterior femora with a broad postmedian brownish band, the apical half of their tibiae and basal third of the

first segment of the hind tarsi brownish. Hair short, brassy yellow, black on the hind legs from the coxae to the middle of the first tarsal segment, long on the posterior surface of the middle femora where a few black hairs are mixed with the pale pile.

Wings hyaline, the anterior border brown, expanded to form a triangular spot covering the cross veins and broad apices of the basal cells and the apex of the anal cell; middle of second basal cell, anal and auxiliary cells and alula hyaline, the immediate base of the wing broadly brownish red. Vein closing the discal cell almost straight; alula large, gently convex behind.

First abdominal segment reddish yellow with the middle blackish; second reddish with a moderately broad dorsal black vitta; third segment black with a gently arched, very narrowly interrupted reddish fascia on the posterior half, the outer ends narrowed. Apical two segments wholly blackish. Venter brownish red, the apical two sternites black; hair short, long on first two segments, black except on the first segment; from the middle of the third segment to the apex forming a dense, rather short lateral fringe. Genitalia black, quite small, the appendages reddish.

HOLOTYPE: Male, Guadalcanal, July, 1944 (C. O. Berg).

This species is very close to *mundula* Wulp, but the description of that species does not mention the reddish yellow face and the pale spots on the pleura, and the hind legs are somewhat more extensively black.

***Baccha bergi*, new species**

Rusty reddish yellow, the abdomen partly black; wings with dark costal border expanded before the middle and at the tip. Length, 9 to 13 mm.

MALE: Head reddish yellow or yellow, the pile all pale brassy yellow. Upper half of the frontal triangle greenish black, the anterior border of the black convex. Vertical triangle shining black, a single row of short hairs extending from the vertex to the ocellar tubercle. Occiput dark in ground color, densely cinereous pollinose. Cheeks

narrow, thinly pollinose behind. Face with a little white pollen below on the sides; in profile very slightly receding below, the tubercle rather large but not strikingly prominent. Antennae pale orange, the arista brown except basally.

Thorax uniform in color, or the disc of the mesonotum slightly darker; sometimes a weak brownish spot on each side of the mesosternum. Pile short, appressed, and black on the disc of the mesonotum, elsewhere pale brassy yellow. Pleura with a trace of whitish pollen. Mesonotum with a narrowly separated pair of black vittae extending from the anterior margin to a little behind the middle and slightly broadening posteriorly; a weak collar of pile on the front margin. Scutellum with short pile, the ventral fringe present.

Legs wholly reddish yellow or yellow and with brassy yellow pile.

Wings narrowly brown in front, the brown color rather triangularly expanded to cover the veins closing the basal cells and again expanded in front of the tip of the third vein; basally the dark color may be rather luteous; alula narrow but not linear. Squamae yellow with brassy fringe. Knob of halteres tinged with brown.

First and second abdominal segments pale, the second slender and with the apex broadly blackish. Third segment mostly reddish yellow, with a median posterior triangle extending to the posterior fourth, and a pair of lateral triangles broadly united in front and extending almost to the apex of the segment. In one male the segment is wholly blackish, but the pale area is indicated by a very thin covering of cinereous white pollen. Fourth segment black with a pair of moderately separated reddish triangles on the basal third; fifth segment all black. Pile short, appressed, black; longer and yellowish on the first segment and sides of the second. Venter rusty reddish, or black, except basally, the hair black. Genitalia reddish to castaneous, the appendages yellow, conspicuously large.

FEMALE: Front very narrow above, shining greenish black except above the antennae, the sides narrowly, thinly cinereous pollinose below. Mesonotum with the

vittae very weak and shorter, only a little darker than the general ground color; pile of thorax shorter. Third abdominal segment shining reddish yellow, with an apical black triangle as in the male, and a very slender basal one; the sides broadly brownish except apically and basally. Fourth segment with the basal half of the subtriangular spots rather rectangular, the inner ends reaching to beyond the middle of the segment. Fifth and sixth segments pale with a very broad median black vitta. Venter shining yellowish, the fourth segment brownish laterally and apically.

TYPES: Holotype, male, and allotype, female, Guadalcanal, February, 1945; paratype, male, July, 1944 (C. O. Berg).

Both males have the black vittae on the mesonotum very conspicuous, but in the female they are scarcely discernible. Despite the variability in abdominal markings, the general pattern is the same and it is to be expected that females will be found with the pattern similar to the male.

***Baccha perpallida*, new species**

Rusty yellow, the abdomen with black markings; mesonotum with transverse black spot behind the middle; wings narrowly pale brown in front. Length, 10 mm.

MALE: So similar to *bergi* that a detailed description is not necessary. The head is the same. The black spot on the thorax occupies about one-fourth of the width, just behind the middle, and is produced forward in the middle as a short, acute triangle. The pile is slightly shorter. The light brown costal border is confined to the costal and subcostal cells and the anterior half of the first basal cell, except apically, where it is conspicuously expanded in the submarginal cell. The third abdominal segment bears a short, brown median vitta basally, and a rather small apical triangle; the fourth is black with two small, widely separated, subtriangular yellow spots, the fifth wholly black. Venter yellow, the fourth sternite brown except basally, the fifth wholly brown. Genitalia brown, the appendages yellowish. Pile as in *bergi*.

HOLOTYPE: Male, Guadalcanal, December, 1944 (C. O. Berg).

The genitalia in this species are conspicuously smaller than in *bergi*, and the mesonotal collar is shorter.

***Baccha vespaeformis* Doleschall**

Baccha vespaeformis DOLESCHALL, 1857, Natuurk. Tijdschr. Nederlandsch Indië, vol. 14, p. 411.

This species has been confused with *rubella* Wulp but is readily distinguished by the yellow spots on the dark rusty reddish thorax.

Male and female, Amboina (F. Muir).

***Baccha rubella* Wulp**

Baccha rubella WULP, 1898, Termés. Füzetek, vol. 21, p. 423.

In the original description van der Wulp describes the apices of the posterior tibiae and the first segment of their tarsi as "somewhat darker." If these areas are brown, the species is wrongly placed in my key, but would differ from all those species following it in the key by having the thorax rusty yellowish. The specimen before me, which is badly damaged, has the legs of uniform color but agrees in other respects with the description. It has posterior black fascia and strong median vitta, and blackish lateral margins on the third and fourth abdominal segments; the fifth segment also has a broad median vitta, the sixth is missing. The head is missing. The pile on the thorax is much more conspicuous and yellowish, the hair being mostly erect and more abundant.

One female, Guadalcanal, August, 1944 (C. O. Berg).

***Syritta orientalis* Macquart**

Syritta orientalis MACQUART, 1842, Diptères exotiques nouveaux ou peu connus, vol. 2, pt. 2, p. 76.

Seven males and one female, Guadalcanal, September and November, 1944, and March, 1945 (C. O. Berg); male and female, Oro Bay, New Guinea, November-December, 1944 (B. Struck).

The species is widely distributed.

***Syritta luteinervis* de Meijere**

Syritta luteinervis DE MEIJERE, 1908, Tijdschr. v. Ent., vol. 51, p. 226.

A single male from Guadalcanal, August ?, 1944.

The pale wing veins serve readily to distinguish this species from others in the region. It was originally described from New Guinea.

MESEMBRIUS RONDANI

This genus was erected for the European *Helophilus peregrinus* Loew, which has the eyes narrowly separated at the middle of the front. In most of the species the eyes of the male are contiguous for at least a short distance. It was on the basis of the greatly narrowed front that Rondani separated his new genus from *Helophilus* Meigen (the correct spelling is *Elophilus*), but there is another character that readily distinguishes both sexes of *Mesembrius*. This is the presence of a group of short, black, nodose hairs close to the base of the first segment of the posterior tarsi. I am aware of only two synonyms of the genus, *Prionotomyia* Bigot and *Tityusa* Hull, both based on African species. In *T. regulus* Hull, the front tarsi are greatly broadened and the hind tarsi are broadened and ornamented with tufts of pile. *Mesembrius rex* Curran, also from Africa, is very similar, but the posterior tarsi do not bear hair tufts. The females are quite plain and lack any character that would separate them from other females of *Mesembrius*.

Mesembrius fulvicauda, herein described, has the hind femora of the male very considerably lengthened and the tibia ends in a long spur, as it does in the female of *gigas* Curran; other species have shorter spurs. Throughout the genus the legs of the males are modified in one way or another, thus furnishing the main characters for the separation of the species. The females are rather similar in appearance and often difficult to determine. I have prepared a key to the Oriental and Australasian females contained in the Museum collection, in the hope that it will aid in the identification of this sex. Unfortunately, the series are small, and it may be necessary to make modifications when larger series are available.

FEMALES OF *Mesembrius*

1. Reddish fascia on second abdominal segment interrupted in the middle. .2

- Reddish fascia entire. *gigas* Curran
2. Tibiae, or at least one pair, broadly blackish apically. 3
All the tibiae and tarsi reddish, over 19 mm. in length.
..... *fulvicauda*, new species
3. Front black pilose on its whole length in the middle. 4
Front wholly pale pilose on the anterior half, or with some black hairs on the shining black spot. 5
4. Anterior femora wholly black pilose on the apical half; band on second abdominal segment broadly interrupted; front wholly black pilose.
..... *bergi*, new species
Anterior femora wholly yellow pilose posteriorly; front pale pilose laterally; band on second segment narrowly interrupted.
..... *niveiceps* de Meijere
5. Face wholly yellow, the pale color extending along the sides of the front. 6
Face with median black stripe, which may be mostly pale pollinose. 7
6. The opaque black of the third abdominal segment occupies more than the basal half in the middle.
..... *peregrinus* Loew
The opaque black occupies the basal two-fifths in the middle, black hair present immediately above the antennae. species?
7. Pollen of the front of almost uniform color; yellow fascia on second abdominal segment narrowly interrupted. *bengalensis* Wiedemann
Pollen of the front brown above, very much darker than on the anterior portion. 8
8. Scutellum with black hairs on the posterior half. 9
Scutellum wholly yellow pilose.
..... *tuberosum* Curran
9. Middle tibiae swollen ventrally for a considerable distance before the middle. *albiceps* Wulp
Middle tibiae without such swelling.
..... *bengalensis* Wiedemann

Mesembrius bergi, new species

Dark species, the lateral margins of the abdomen wholly shining black; front of female black pilose; wings tinged with brown, broadly brownish in front on the basal two-thirds. Length, 11.5 to 13 mm.

FEMALE: Head black in ground color; front brown pollinose, the sides broadly brassy yellow pollinose on the lower three-fifths, the large bare area above the antennae wider than high; the dark brown pollen is divided in the middle by a slender line of brown pollen extending forward from the median ocellus; pile black with very little pale pile on the anterior orbits. Occiput with rich yellowish brown pollen and black hair above; occipital pollen cinereous, yellowish towards the orbits, narrowly white along the orbits; pile pale golden yellow. Cheeks yellow pollinose and pilose posteriorly, thinly cinereous pollinose in front. Face with cinereous pollen, the pile golden yellow above, becoming white and shorter below, the shining black median stripe extending to well above the middle. Antennae brownish red.

Mesonotum brownish orange, the dark vittae opaque brownish black, the outer ones subshining posteriorly, the middle one only thinly pollinose behind and reaching obscurely to the posterior margin. Pile light brassy yellow, more golden laterally, black on the posterior half of the black stripes, on the pale vitta between the lateral dark vittae and the posterior calli, the upper surface of the latter with short, coarse black hair. Pleura with cinereous pollen, the pile golden yellow above, becoming whitish below. Scutellum subtranslucent yellowish red, the border with pale pile, the disc with coarser black hair.

Legs black; the basal fourth of the front, third of the middle, and immediate base of the hind tibiae pale reddish; tips of the femora and basal segment of the middle tarsi reddish. Hair black, golden yellow posteriorly on the basal half of the front tibiae and on the basal two-thirds of the middle pair, some pale pile at the base of the latter on the ventral surface; posterior femora with golden pile above and posteriorly except on the apical fourth, and some yellow hairs ventrally on the basal

half or less. Posterior tibiae not produced.

Wings tinged with brown, broadly brownish in front on more than the basal half. Squamae and fringe bright orange. Halteres yellowish.

Abdomen black, with three light reddish fasciae, the first broadly interrupted in the middle. First segment gray pollinose in the middle, white pilose but a few black hairs towards the sides. Second segment opaque, broadly shining behind, the shining band narrowing laterally and not reaching the sides and for the most part very thinly brown pollinose; reddish band formed of two outwardly broad, gradually narrowing spots, their inner ends obtusely rounded; pile yellow in front of the posterior opaque band, black posteriorly and on the sides except on the broad base. The pale fascia on the third segment is evident laterally, and quite narrow in the middle where it is about half as wide at the opaque fascia, twice as wide laterally, and narrowly separated from the base of the segment except towards the sides; on the disc of the segment the opaque band is followed by brownish gray or brownish pollen, the broad apex of the segment shining; fourth segment rather similar to the third, but the pale fascia is less narrowed in the middle and covered with yellow pollen, the opaque fascia is narrower and semi-interrupted; on these two segments the pile is black except on the yellow areas and lateral margins. The fifth segment bears a pair of moderately large, basal, brownish yellow, semi-circular pollinose spots, the rest of the surface very thinly brown pollinose, the pile all yellow. All the pale bands are well separated from the lateral margins. Venter black, more or less reddish subbasally, thinly cinereous pollinose, the hair pale golden yellow.

TYPES: Holotype, female, and paratype, female, Guadalcanal, February, 1945 (C. O. Berg).

Mesembrius fulvicauda, new species

An extremely large species, the males about an inch in length and with long, bushy hair on all the tibiae, the females smaller and with all the tibiae and tarsi reddish. First pale abdominal band inter-

rupted, the two following entire; apex of abdomen reddish, with golden to fulvous pile. Length, males, 23 to 25 mm.; females, 20 to 22 mm.

MALE: Frontal triangle shining black, the sides narrowly whitish or yellowish pollinose; pile whitish laterally, black on the shining area but rather golden on the upper part. Vertical triangle very long and narrow, the eyes contiguous for a distance less than the length of the ocellar triangle, the pollen cinereous brown to dark golden brown; pile brassy yellow to reddish, black on the shining ocellar tubercle. Vertex and occiput with bright yellowish red pollen and with golden to bright tawny pile above; posterior orbits narrowly cinereous, the inner occiput mostly cinereous pollinose; pile of posterior orbits and cheeks pale to dark golden. Cheeks pale pollinose posteriorly, shining black in front but with thin brown pollen. Face reddish yellow, with broad median black stripe, the pollen golden, paler along the orbits, the pile golden yellow to pale tawny, sparse and black on the black stripe; black stripe thinly reddish brown pollinose. Antennae reddish, the third segment sometimes with brown tinge; arista wholly reddish.

Thorax black in ground color, the lateral margins and scutellum reddish. Mesonotum bright reddish yellow pollinose, with three dull black vittae, the median one becoming obsolete at the posterior fifth, the outer ones slender inside the humeri and narrowly separated from the posterior margin; all appearing brown from anterior view. Pleura with cinereous yellow to pale golden pollen, shining beneath the squamae and broadly black anteriorly. Pile golden yellow, being short on the disc, longer and tawny on the borders of the mesonotum and on the upper edge of the pleura; black on the upper surface of the postalar calli. Scutellum with short tawny or golden yellow pile, on the disc with black hairs intermixed, or they may predominate on the apical half.

Legs reddish, the coxae, basal half of the anterior four femora, and basal four-fifths of the posterior pair black, the dark color dulled except ventrally by cinereous or cinereous yellow pollen. Pile on the femora

tawny, long, and dense on the posterior surface of the anterior four and on the anterodorsal surface of the hind pair basally; a tuft of black hair anteriorly near the apex of the middle femora, and some short black spinose hairs on the ventral surface of the posterior pair at the apex. Front tibiae with short golden pile, on the posterior border with long, dense black pile bordered above with some long, tawny hair. Middle tibiae with short, tawny hair above, black below, both sides with long, dense, apically crinkly hair forming a dense brush on the whole length and continuing along the sides of the tarsi where it becomes shorter and thinner to the apex. Posterior tibiae with similar brush on the anterior surface, but with a conspicuous curl at the basal third, the posterior surface with a brush on the apical half, the anterior brush continued along the tarsi. The pile on the tarsi is short, tawny to golden yellow, the front pair with some black hair in front. The posterior femora are very long, their tibiae about two-thirds their length and with a strong anteroventral spur at the apex.

Wings tinged with luteous or brownish yellow, the veins reddish basally and anteriorly. Squamae and fringe yellowish red. Halteres reddish.

Abdomen broad basally, narrowing to the apex of the third segment, the fourth with parallel sides. First segment brownish black, narrowly reddish beneath the scutellum. Second segment opaque black with the posterior border shining, the tip narrowly reddish; a very broad, narrowly interrupted orange fascia extends across the segment and is carried forward laterally towards the base; the inner ends of the spots are gently convex in front; anterior black band two-thirds as wide as the posterior. Third segment subopaque black or brown, the apex broadly reddish; pale orange on the basal third in the middle, the band widening towards the sides but conspicuously narrowed just before the lateral margins. Fourth segment shining, dark reddish to castaneous, the base narrowly yellowish, the apex and sides broadly reddish. Genitalia shining dark reddish. Lateral borders narrowly reddish on whole

length behind the first pale fascia. Pile very short, erect, yellow to brassy yellow, black on the posterior black fasciae, long and tawny on the sides basally, becoming shorter and golden apically, the golden hair extending across the apex of the fourth segment. On the fourth segment the hair is coarser, sparse, and appressed on the disc. Hair on genitalia wholly pale. Venter black, the incisures yellow, pile long, golden yellow. Fourth visible sternite reddish, with short, sparse, appressed golden yellow hair, the apex emarginate in the middle, the lobes moderately long and with short, stout, tawny hairs apically.

FEMALE: A large, rectangular, shining black spot above the antennae, the front elsewhere thickly golden yellow pollinose except about the ocelli, where the pollen is more grayish; pile all rich golden yellow, a few black hairs above the antennae; black facial vitta a little narrower. Pile on thorax shorter; no black hairs on the scutellum. Legs simple, the pile normal, golden yellow, a few black hairs on the under side of the posterior tibiae, which have a row of black spinules ventrally on the basal third, their femora with black spinules below on the apical fourth. There is a broad band of reddish yellow pollen on the base of the fourth segment, followed by a broader, opaque black band behind which the segment is shining black; lateral margins and apex reddish, on the apical half fringed with close-set, bright tawny hair; fifth segment shining red, with similar apical fringe. Venter black, with yellowish incisures and reddish apex; most of the fourth sternite and the fifth with coarse black hair, the apex of the fifth with a tawny fringe.

TYPES: Holotype, male, and allotype, female (in coitus), Guadalcanal, December, 1944 (C. O. Berg). Paratypes, two males and one female, Guadalcanal, July 23, 1945 (Frank Cilley); and male, Bougainville, 1944 (W. G. Downs).

Despite the remarkably lengthened hind femora of the male, this species is a typical *Mesembrius* with the typical globulose hairs present on the base of the posterior tarsi; they are black and numerous in the female, but rather difficult to locate in the

male, the adjacent hairs being longer. The legs of all the known females are simple, but in most males there are ornamentations composed of pile and also morphological structures. In some the tarsi are greatly broadened. It is possible that the male of *gigas* Curran, from Malaya, may somewhat resemble this species. The female has a length of 19 mm., but the tarsi are black and the tibiae partly black. *M. vestitus* Wiedemann also has mostly black tibiae and tarsi, while *insignis* Walker has the tibiae black apically.

Axona chalcopyga Wiedemann

Eristalis chalcopyga WIEDEMANN, 1830, *Ausereuropäische zweiflügelige Insekten*, vol. 2, p. 178.

Four males and one female, Guadalcanal, October and December, 1944, and January and June, 1945.

This is a large, metallic blue species with the apex of the abdomen orange. It is widely distributed in the Indo-Australian region.

ERISTALIS LATREILLE

The collection contains representatives of five species, two of which are undescribed. I present a key to the bright metallic green or blue species that are likely to occur in the region:

METALLIC GREEN OR BLUE SPECIES

1. Arista plumose.....4
Arista bare.....2
2. Fourth abdominal segment with three opaque spots... *inscripta* Doleschall
Fourth segment with at most one spot.....2
3. Third abdominal segment with a broad opaque band formed of an oval central spot and slightly oblique spots normally united with it; fourth segment with basal median opaque triangle..... *bergi*, new species
Third and fourth segments wholly shining (New Hebrides).....
..... *luciliomima* Hull
4. "Abdomen blue-green".....
..... *muscoideus* Walker
"Abdomen red-yellowish copper colored"..... *cuprius* de Meijere

***Eristalis inscripta* Doleschall**

Eristalis inscripta DOLESCHALL, 1857, Natuurk. Tijdschr. Nederlandsch Indië, vol. 14, p. 407, pl. 9, fig. 4.

The collection contains a male and a female, April, 1944.

There has been much confusion concerning the identity of this species. De Meijere apparently identified the male correctly from New Guinea, but was confused about the identity of the female. His observations indicate that the females represented both *inscripta* and a second species, probably the one herein described as *bergi*. The dark markings on the abdomen of the female are very similar to those of the male. The front is brown pollinose on about the upper half, in front of the ocelli; the upper fifth of the front is shining.

There may be some doubt about the specimens from Guadalcanal being *inscripta*. Doleschall's specimens came from Amboina, and it is to be noted that *E. splendens* de Guillou and *E. metallica* Doleschall have long been confused, the latter having been placed as a synonym of *splendens*, although abundantly distinct. A similar condition exists in the case of *Baccha vespaeformis* Doleschall and *B. rubella* Wulp, the former from Amboina, the latter from New Guinea, although these species have never been synonymized. To offset the possibility that my specimens are not *inscripta*, we find very many instances where the same species occurs in Amboina and in New Guinea, *Axona chalcopyga* being one example, but this species has a very wide range.

***Eristalis bergi*, new species**

Bright blue or violaceous; front of female shining, with narrow median dull line, abdomen with opaque fasciae. Length, 10 to 11 mm.

FEMALE: Front rather narrow, shining steel blue and violaceous, the orbits cinereous pollinose below and narrowly brown pollinose on the upper fourth; an opaque median line extends from the ocelli to the anterior third of the front; pile black. Posterior orbits silvery white pollinose except above, the pile pale brassy yellow, black above. Cheeks metallic green on the

posterior half, black in front, the pile brassy. Face black, very broadly reddish on the sides, the pale areas cinereous to brassy pollinose, the hair short and brassy yellow. Antennae reddish, brown above, the arista brown, bare; third segment short oval. Eyes bare.

Dorsum of the thorax blue, the pleura green, all strongly violaceous. Mesonotum with the anterior border, a pair of median vittae on the anterior half, and the borders of the suture brownish pollinose but appearing brownish yellow from posterior view. Hair very short, black, appressed; whitish on the lower half of the pleura; scutellum with some bristly hairs on the free border.

Legs blackish, the femora mostly blue or violaceous.

Wings hyaline or sometimes largely brownish yellow, the stigmal cell and a spot on the anterior cross vein brown. Squamae grayish brown. Halteres reddish yellow.

First abdominal segment usually green; second with a narrow, incomplete basal band, a broad apical band and median line opaque brownish, often cupreous; third segment with a broad dull band lying mostly behind the middle, strongly expanded in the middle but somewhat narrowed on each side of the expanded area; fourth segment with a rather diamond-shaped basal spot in the middle. Hair short, black, appressed; yellowish, erect, and long on the fourth and fifth segments and on the venter.

Types: Holotype, female, and two paratypes, females, Guadalcanal, September, 1944 (C. O. Berg); female, Little Florida Island, Solomons, March, 1945 (G. E. Bohart), and female, Munda, North Georgia, February, 1945 (L. A. Cornwell).

This species resembles *inscripta* Doleschall but is readily distinguished by the shape of the dull areas and by the presence of only a line of opaque in front of the ocelli. In *inscripta* the front is pollinose on the upper fourth or more.

***Eristalis marfax*, new species**

Black; thorax with two transverse pale pollinose fasciae; wings brownish to beyond the middle on the anterior half or

more; abdomen aeneous with opaque fasciae. Length, 10 to 11 mm.

FEMALE: Front rather narrow, opaque dark brown on about the upper half, cinereous white pollinose in front except for a large, shining black area above the antennae; the orbits are broadly pollinose. Pile black, some white pile on the sides below. Posterior orbits brown above, white below, the pile black on the brown portion, white below and on the face and cheeks. Face and cheeks densely white pollinose, a triangle on the front of the cheeks and a broad facial stripe that does not reach the antennae shining black. Antennae brown, the third segment orange; arista brown, very short pubescent basally. Eyes short whitish pilose above.

Thorax dull brownish black; a broad, cinereous yellow pollinose band extends across the mesonotum immediately in front of the suture but is divided by a broad, anteriorly geminate, yellowish brown vitta that extends from the anterior margin to slightly behind the suture; a second, incomplete, cinereous pollinose band lies in front of the scutellum. Pleura cinereous or whitish pollinose except for a large brown area on the pteropleura. Pile white, black behind the suture and on the brown pleural spot. Scutellum opaque black, the free border aeneous; pile white or pale yellow. The pile is short, erect or suberect.

Femora shining black, with reddish tips; tibiae brown, the anterior pair reddish on the basal third to half, the middle pair reddish with the ventral surface brown on the apical half, the posterior pair reddish above on the basal third or less; tarsi brown. Pile whitish, black on the tarsi and on the anterior surface of the posterior femora.

Wings light brownish, becoming cinereous hyaline posteriorly and apically. Squamae yellowish, with white fringe. Halteres reddish yellow.

Abdomen aeneous, with opaque black markings. First segment gray pollinose. Second segment with a broad basal band and a broader posterior opaque band, broadly connected in the middle, the aeneous spots narrowed and with the ends rounded inwardly; apex of the segment shining on the median third. Third seg-

ment opaque on less than the posterior half, the band rectangularly produced in the middle but not reaching the base of the segment, the apex of the segment rather broadly shining on the median half. The opaque fascia on the fourth segment is less than one-half the length of the segment in width; in the middle its front margin is at the basal fourth of the segment, the outer front margin at the posterior third; the shining apical portion is triangular and extends forward to the apical third of the segment. Fifth segment opaque with the broad sides and the medianly broadened apex shining black. The sides of the abdomen are at least moderately shining on their whole length. Pile pale yellowish, white on the first segment, black on the posterior half of the second segment and on the opaque portion of the third. Venter black, thinly cinereous pollinose and whitish pilose.

TYPES: Holotype, female, and paratype, female, Guadalcanal, February, 1945 (C. O. Berg).

This species bears a close resemblance to *niger* Wiedemann, but there are numerous differences. In *niger* the front is somewhat wider and the facial tubercle is much wider and the shining area extends to the lateral fourth of the face, a character that should serve to separate the males of the two species; the shining apices of the segments are also broader and the apex of the scutellum is broadly aeneous. I have examined the type of *niger* and have seen many specimens from Java and Malaya, the former being the type locality.

Eristalis resoluta Walker

Eristalis resoluta WALKER, 1859, Proc. Linn. Soc. London, vol. 3, p. 95.

A series of 20 males and seven females from Guadalcanal, from September, 1944, to January, 1945, and April, 1945.

The abdomen is dull black and cupreous or coppery red, the apical segments with three opaque black spots, the wings brown, somewhat paler basally.

Eristalis collaris de Meijere

Eristalis collaris DE MEIJERE, 1908, Tijdschr. v. Ent., vol. 51, p. 258.

Thirty-one males and 14 females from Guadalcanal, from October, 1944, to April, 1945.

This is a small species with reddish legs and a broad, pale pollinose fascia in front of the mesonotal suture. It was originally described from New Guinea.

LATHYROPHTHALMUS MIK

The collection contains two new species belonging to this genus. In order to determine their relationships it has been necessary to restudy the Oriental and Australasian material in the Museum collection with the result that some species previously considered to be synonyms are now recognized as distinct. Unfortunately, the material available is insufficient to enable me to revise the genus, but it is apparent that the number of species will be found to be considerably greater than the number now recognized. The key which follows does not include *kochi*, *lunatus*, and *obscuritarsis* de Meijere, or *ferrugineus* and *connectans* Hervi-Bazin, since these are not represented in the collection. However, *obscuritarsis* is probably the same as *quinquelineatus* Fabricius since the color of the tarsi is generally the same as in African specimens of the latter, of which the only specimen I have seen from the Orient is a male from Canton, China. The characters used in the key are believed to be of use in separating both sexes, but are sometimes based upon only one sex. The color and width of the front of the females furnish excellent characters for the separation of this sex, in which the species are sometimes more easily recognized than the males.

TABLE OF SPECIES

- | | |
|---|---|
| 1. Scutellum black.....2 | Mesonotum with pale pollinose discal vittae.....6 |
| Scutellum reddish, yellowish, or translucent, at least on the apical half.....10 | 4. Third and fourth abdominal segments each with a pair of broadly separated, parallel, cinereous pollinose spots..... <i>selectans</i> Curran |
| 2. Abdomen shining metallic bluish black, the third and fourth segments each with a narrow, somewhat sinuate, anteriorly arched, opaque black fascia... <i>nitidus</i> Wulp | Third and fourth segments with transverse pollinose spots or none.....5 |
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| | 6. Second abdominal segment with pale pollinose fascia or partly pale in ground color.....7 |
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| | 10. Mesonotum with strongly contrasting black and pale vittae.....11 |
| | Mesonotum ochraceous pollinose, the vittae only a little darker; an irregular dark fascia between the wings..... <i>diffidens</i> , new species |
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| | Wings with at most a black stigmal spot or weak, diffuse clouding...13 |
| | 12. Basal half of marginal cell brown; anterior four femora usually all reddish..... <i>splendens</i> Le Guillou |
| | Basal half of marginal cell hyaline; |

Face dull golden pollinose and short golden pilose; the oral margin and the area about the tubercle shining black, the upper half of the tubercle brownish red; the usual lateral bare stripes are fused with the black tubercular spot but extend upward a short distance on each side. The tubercle is large, oval, and devoid of hair. Antennae reddish, the third segment oval, broadly brown above; arista brown on apical third, practically bare. Eyes with very short sparse pale hairs.

Thorax black in ground color; mesonotum densely ochraceous pollinose, with three subopaque blackish vittae which do not quite reach the posterior border, the median one divided by a brown line on the anterior half; posterior calli shining blackish; pile short, rich reddish yellow, black on the black portions. Pleura with cinereous yellow pollen, a broad, bare, rather aeneous band extending from behind the front coxae to below the base of the wings; pile reddish yellow, paler below. Scutellum shining blue black, the disc somewhat dulled and with short, appressed black hair, the free border with longer, golden hair.

Legs shining reddish, the coxae and basal half of the femora black, the basal fifth of the posterior tibiae and basal third of the anterior four pale yellow; basal two segments of middle tarsi yellow, the apical two or three tarsal segments brownish. Pile black, yellow on the yellow areas, on the upper surface of the posterior femora, and partly yellow on the basal half of their lower surface.

Wings hyaline, with luteous tinge on basal half in front; stigma with basal and apical black spots, the space between them bright brownish yellow. Squamae brown, the base broadly yellowish. Halteres yellow.

Abdomen black, mostly opaque brownish black, with opaque reddish yellow markings. First segment reddish yellow with only the sides blackish. Second segment with an arched, subbasal reddish band that is narrowly interrupted in the middle and widely separated from the lateral margins, the outer ends lying on the middle of the segment, the width equal to about one-

fourth the length of the segment. Third and fourth segments with a pair of widely separated oblique reddish spots, their outer ends pointed and at, or slightly behind, the middle of the segment. Fourth segment with a pair of widely separated, oval, parallel, reddish yellow pollinose spots; the spots and band on the preceding segments with similarly colored pollen. The broad sides of the second segment and broad lateral triangles on the third and fourth shining, the apices of these segments also shining black on the median half or more. Fourth segment with the broad apex and sides shining. Pile very short, erect, black, yellowish on the pale areas of the basal four segments and on their lateral margins basally; longer and all black on the fifth segment. Venter shining black, the hair black, pale basally.

HOLOTYPE: Female, Guadalcanal, February, 1945 (C. O. Berg).

This species is readily separated from the other members of the *punctulatus* group by the black scutellum and face, and from other species with black scutellum by the shape of the abdominal markings.

***Lathyrrophthalmus diffidens*, new species**

Mesonotum ochraceous with interrupted blackish band behind the suture and weak vittae; pile on eyes very short and sparse; tarsi reddish yellow. Length, 14 mm.

MALE: Frontal triangle rather small, shining black, the lunula castaneous with a yellow spot above each antenna; broadly bordered with yellowish brown pollen laterally and less broadly so above; pile black. Ocellar triangle small, black, brown pollinose in front of the ocelli; pile black, but some yellow hairs just at the vertex. Occiput cinereous pollinose except above, the pile yellowish above, white below. Face and cheeks black, brownish yellow pollinose, and short yellow pilose. The posterior portion of the cheeks is shining except on the margins, and the pollen is thin anteriorly between the eye and oral margin, the oral angles shining black; tubercle shining black and bare, with a broad lunulate black band continuous with it for half its length, the ends curving outward, this band pilose; the black tubercle is con-

nected by a narrow stripe to the narrowly shining oral margin. Antennae reddish, with the broad upper border of the third segment and the apical half of the arista brown or black.

Thorax black in ground color with the sides and posterior border of the mesonotum and the scutellum reddish. Pollen ochraceous, with six darker vittae, the median four much abbreviated and rather blackish behind the suture, and more or less shining; in front of the suture they are only a little darker than the adjacent pollen. The lateral vitta is shining black or brown and extends from the humeri to above the base of the wing; it is interrupted at the suture and narrowly divided on its whole length in front of the suture. Pile rather thick but short, of a rich reddish yellow, paler on the sides and pleura; on the dark vittae there are black hairs intermixed but these are not apparent from frontal view. The hair on the disc of the scutellum is very short and black, tawny on the base and free border. The pollen on the pleura is paler than on the dorsum, and there is a large, almost bare spot below the wings that extends onto the mesopleura.

Coxae brownish red, the posterior pair with yellowish pile. Femora castaneous with yellow tips, the posterior pair darker and with reddish apex; pile black, yellow basally on the upper and lower surfaces of the posterior pair and posterodorsally on the middle pair; long and dense on the posterior surface of the middle pair. Anterior four tibiae reddish yellow on the apical half, extremely pale yellow basally; hair black, very pale yellowish on the basal half of the middle pair and on the base of the front pair; posterior tibiae castaneous with the apex reddish and the base pale yellow, the pile wholly black. Tarsi red-

dish with black hair, the basal segment of the middle pair yellow and with yellow hair.

Wings hyaline, the veins mostly reddish; the short, pale luteous stigma is limited by black at each end. Squamae yellowish, becoming brown on the very broad border; fringe rather golden on the lower lobe and brown on the upper. Halteres reddish yellow.

First abdominal segment reddish yellow, with pale yellow pile. Second segment reddish, with the base, except laterally, subopaque black, the posterior third dull blackish except on the immediate apex medianly, the lateral borders shining brown. Third segment reddish on the basal half towards the sides, less so in the middle and at the sides, black posteriorly, with a broad, dull band that is produced forward in the middle but does not quite reach the base of the segment and is widely separated from the lateral margins. Fourth segment shining black but from some views the disc appears dull, on more than the basal half. Pile black on the second segment except at the anterior angles, black on the third except on the reddish fascia, the fourth segment with basal band of yellow pile that expands laterally to cover more than two-thirds of the segment. Genitalia black, yellow pilose. Venter yellowish, the fourth and fifth sternites black; pile pale yellow.

HOLOTYPE: Male, Guadalcanal, January, 1945 (C. O. Berg).

This is the first recorded species of the genus from the Pacific region in which the thorax is not strongly vittate. Other species with non-vittate pollinose thorax are known from Africa. *L. selectans* Curran, from Selangor, has the mesonotum shining black.

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A NEW SUBSPECIES OF *LIMENITIS ARCHIPPUS* (LEPIDOPTERA, NYMPHALIDAE)

BY RALPH L. CHERMOCK

In 1940, Carlos C. Hoffmann noted specimens of *Limenitis archippus* occurring in Vera Cruz which, at the time, he compared with *L. archippus halli* (Watson and Comstock) (1920, p. 449). These specimens were received at the American Museum of Natural History with the Hoffmann collection. One male had a type label with an unpublished manuscript name. Two other males were marked with paratype labels. Apparently Hoffmann had recognized these specimens as constituting a distinct subspecies of *Limenitis archippus*, but the description was never published. I take pleasure in naming this new subspecies in honor of its original discoverer, the late C. C. Hoffmann.

Limenitis archippus hoffmanni, new subspecies

Basilarchia archippus halli HOFFMANN (nec Watson and Comstock), 1940a, pp. 279-280.

Basilarchia archippus halli HOFFMANN, 1940b, p. 689.

The length of the forewing, measured from the base to the apex, varies from 32 to 34 mm. in the male, with the average length being 32.5 mm. The holotype measures 33 mm.

On the upper surface the color and maculation suggest an intergradation between *L. archippus archippus* (Cramer) (1775, vol. 1, p. 24, pl. 16) and *L. archippus obsoleta* Edwards (1882, p. 22). The ground color of the limbal area is similar to that of *L. archippus archippus*, while the discal and basal areas suggest the color of *L. archippus obsoleta*. The narrow black maculation along the veins and the narrowing of the black marginal band of both wings approach *L. archippus obsoleta*.

The diagonal black band across the apex of the primaries is reduced, but pos-

sesses the characteristic white spots in cell R_5 and cell M_1 . In cell M_2 , however, this band is reduced to a minute black spot which may or may not be ocellated with white. In cell M_3 , a pinpoint black spot may be present or absent. This diagonal band is well developed in *L. archippus archippus*, *L. archippus floridensis* (Strecker) (1878, p. 143), and *L. archippus watsoni* (dos Passos) (1938, p. 243) and meets the marginal black border. In *L. archippus obsoleta* this band is reduced to a series of four large subequal white spots, thinly bordered with black, but never reaching the outer margin.

On the secondaries the transverse discal black band characteristic of *L. archippus* and its subspecies is completely lacking, although faintly showing through the wing from the lower surface. The white intracellular lunules of the outer margin tend to become obscured in *L. a. hoffmanni*.

The lower surface is very similar to *L. a. archippus*, however; the black bands across the middle of the wings are reduced in width. The discal and basal areas of the primaries tend to have the darker brown color of *L. a. obsoleta*.

The valves of the male genitalia have a large, terminal, ventrally directed hook characteristic of *L. archippus* and its subspecies. The small pointed process dorsal to the hook, which frequently occurs in *L. archippus archippus* and is best developed in *L. a. obsoleta*, is lacking. This latter character is variable in this species and is not of subspecific diagnostic value.

TYPE SERIES: The type male is from Misantla, Vera Cruz, Mexico, July, 1909 (C. C. Hoffmann). Five paratypes: one male, Misantla, Vera Cruz, Mexico, July, 1909 (C. C. Hoffmann); one male, Pa-

pantla, Vera Cruz, Mexico, July 12, 1925 (C. C. Hoffmann); three males, Tamazunchale, Hidalgo, Mexico (D. Romanoff). The type and paratypes are in the American Museum of Natural History.

Limenitis a. hoffmanni is the southernmost representative of its genus in the Western Hemisphere, occurring in Vera Cruz and Hidalgo. At present its known distribution appears to be discontinuous with the other subspecies of *L. archippus*. However, more thorough collecting in northern Mexico may extend its range. It is possible that this subspecies will intergrade with *L. a. watsoni* along the coastal areas and with *L. a. obsoleta* in north central Mexico.

The resemblance of *L. archippus* to

Danaus menippe menippe (Hubner) (1816, p. 16) is well known. It is interesting to note that the subspecific variation of *L. archippus* corresponds to the prevalent species of *Danaus* found in the region. In southern Canada and northern United States, *L. a. archippus* closely resembles *D. m. menippe*. In the Gulf states, *L. a. watsoni* and *L. a. floridensis* occur, which closely resemble the common *Danaus gilippus berenice* (Cramer) (1779, vol. 3, p. 22). In southwestern United States, where *Danaus gilippus strigosa* (Bates) (1864, p. 32) abounds, it is mimicked by *L. a. obsoleta*. *L. a. hoffmanni*, on the upper side, most closely resembles *Danaus eresimus monteruma* Talbot (1943, p. 120), a common danaid in Central America.

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ADDITIONS TO THE KNOWLEDGE OF THE CYPRAEIDAE BASED ON THE COLLECTIONS OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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This paper is concerned with the extension of knowledge pertinent to the Cypraeidae from the West Indies and Pacific Ocean based on unworked collections housed in the American Museum of Natural History. Data are included to indicate size variation in certain species; specific localities are cited for species of cowries where it seems to the writer that specific island locality records are lacking in the literature; and notations concerning unusual individuals of a species are noted.

Schilder and Schilder (1939) in their monograph on living Cypraeidae have given general distributional data for the species listed here. The writer, for the past several years, has attempted to present specific island listings of cowries based on reliable collections and on collection data from experienced field collectors in the hope that in the future a monograph will be forthcoming to present accurately and specifically the distribution, especially in the Pacific, of this widely collected family of mollusks. (Ingram, 1937a, 1937b, 1938, 1939a, 1939b, 1940, 1944; and Ingram and Kenyon, 1945a, 1945b.)

The danger in compiling such lists in the future lies in the mixing of locality data with the extensive collecting during the

war that was especially directed towards such attractive shells as the cowries. (Spicer, 1941; Ingram, 1944; Ingram and Kenyon, 1945a.) During the war years shell collectors returning from the Pacific, wanting cowries identified, often interviewed the writer. It was not uncommon to have a cigar box or sack opened on my desk, revealing a hundred or so shells, to have the collector pick shells out of the pile and, without any recorded collection data and relying on memory alone, to locate them specifically to three or four island groups.

The material from the various localities was obtained by the following collectors: Santo Domingo, Armstrong Santo Domingo Expedition; Tobago, Mrs. L. Whitlock; Ie Shima, Mr. Joseph Lo Pinto; Eniwetok, Mr. Alfred Belohlavek; Tuamotu, Dr. H. L. Shapiro; Galápagos, Mr. Clarence Hay.

Appreciation is expressed to Dr. Ernst Mayr, Curator of the Whitney-Rothschild Collections, and to Mr. John C. Armstrong, Assistant Curator of Invertebrates for their cooperation in placing Cypraeidae material of the American Museum in the writer's hands.

SPECIFIC LOCALITY LISTINGS

SOUTH END OF EL CAYO

Cypraea cinerea Gmelin

This species is one of the cowries which has received but little attention in the literature. The measurements of a fine series of six individuals is worthy of record;

they are as follows: 36.40-24-21, 33.80-22.10-18.80, 33-23.90-19.80, 29.60-20.60-17.10, 27.10-18.50-14.80, 25.20-18-15.90.*

Cypraea spurca Linnaeus

Cypraea zebra Linnaeus

* Measurements are in millimeters and approximate to the nearest tenth of a millimeter; the measurement sequence is length, width, and height.

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TOBAGO, WEST INDIES

Cypraea cinerea Gmelin

The measurements of 10 beach shells are added here to those of this species from El Cayo: 36.60-23-19.40, 34.50-22-18.70, 33.70-21.10-18.10, 27.80-17.70-15.80, 26.30-16.50-14, 26.20-16.50-13.80, 27-17-14.60, 26.70-17-14.60, 25.40-17.40-15.20, 25.50-16-14.

Cypraea spurca Linnaeus

IE SHIMA OFF OKINAWA, JAPAN

Cypraea annulus Linnaeus*Cypraea caputserpentis* Linnaeus*Cypraea lynx* Linnaeus

ENIWETOK, MARSHALL ISLANDS

Eniwetok (Brown) Atoll is situated at approximately 11° 21' N., 162° 20' E., 165 miles westward of Bikini Atoll. It is 21 miles long in a northwest and southeast direction. Three natural entrances lead into the lagoon.

Cypraea annulus Linnaeus*Cypraea carneola* Linnaeus*Cypraea caputserpentis* Linnaeus*Cypraea intermedia* Gray*Cypraea moneta* Linnaeus*Cypraea poraria* Linnaeus*Cypraea ventriculus* Lamarck

Four freshly collected specimens are in the collection. They vary in size from 54-33-25.60, 43.80-29.40-22, 41.20-27-19.10, 38.60-25-18.

PENRHYN, TONGAREVA ISLAND

Penrhyn, Tongareva Island, one of the scattered islands near the Equator commonly referred to as the Line Islands, is situated at 09° 00' S., 158° 03' W. and consists of numerous low islets. Locally this island, under the Dominion of New Zealand, is known as Mangorongo. The lagoon is studded with coral heads, and three passes open into it. The entire atoll is approximately 12 miles long by 7 miles wide.

Cypraea annulus Linnaeus

Mature individuals of this species varied in size from 24.90-18.40-12 to 9-5.70-4.20. Three specific collections showed the following variations in size: collection 1, five individuals, 24.90-18.40-12 to 17.50-12.70-

8.50; collection 2, 17 individuals, 12-7.20-5.50 to 9-5.70-4.20; collection 3, 22 individuals, 13-9.50-6.70 to 9.50-6.50-4.90. Two individuals are nearly circular in outline.

Cypraea caputserpentis Linnaeus*Cypraea carneola* Linnaeus*Cypraea erosa* Linnaeus*Cypraea fimbriata* Gmelin*Cypraea helvola* Linnaeus*Cypraea irrorata* Gray*Cypraea isabella* Linnaeus

Eight individuals show such a variation in size that it is worthy of recording here. All specimens are mature, and the largest is slightly more than twice as large as the smallest: 36-20-17, 27-14-12, 25.20-13.20-12, 25-13.60-11.80, 24.50-13-11, 23.50-12-10, 20-10-8.50, 17.70-9-7.50.

Cypraea intermedia Gray*Cypraea moneta* Linnaeus

One collection of 17 individuals illustrates the great size variation present among the great majority of species of Cypraeidae. Such variation may lead those who have not collected large series of individuals of a species to think that a new species may be in hand, unless extensive series are studied. Subspecific division of a species based on size seems hardly justified with the great variation existing in the Cypraeidae.

The largest individual measures 31-23.80-16 and the smallest 18-11.50-8.90. The mean measurements for the 17 individuals was approximately 25-18-12.

A yellow annulus is well defined on the dorsum of seven, ill defined on eight, and entirely absent on two individuals. Nine individuals have the lateral nodules on the shell well developed and in eight they are either poorly developed or absent.

Cypraea poraria Linnaeus*Cypraea punctata* Linnaeus*"Pustularia" cicerula* (Linnaeus)*Nuclearia nucleus* (Linnaeus)

NAPUKA ISLAND, TUAMOTU ARCHIPELAGO

Napuka, situated at 14° 09' S., 141° 14' W., consists of a series of islets connected by an irregular coral reef. The lagoon has no passage.

Cypraea arenosa Gray

Cypraea caputserpentis Linnaeus
Cypraea intermedia Gray(= *Cypraea depressa* Gray)

One not fully mature individual is among the largest specimens that the writer has seen; it measures 42-27.50-22. Two fully mature individuals measure 38-28-20 and 30-23-15.15.

Cypraea lynx Linnaeus
Cypraea moneta Linnaeus

Nine individuals of this species from one collection show an interesting color variation: five have a yellow base and a milk white dorsum and lateral margins; two have a yellow-tinged dorsum and a white base; and two have the base and dorsum yellow tinged, the yellow on the base being the more prominent.

Cypraea scurra Chemnitz

FANGATAUFA (COCKBURN) ISLAND, TUAMOTU ARCHIPELAGO

Fangataufa (Cockburn) Island is located at 22° 15' S., 138° 45' W. It is a small oblong atoll 5 miles long by 3 miles wide. There is no passage into the lagoon.

Cypraea arenosa Gray
Cypraea intermedia Gray(= *Cypraea depressa* Gray)

Two adults measure 40.40-29-20.60 and 33-23.50-15.90.

Cypraea talpa Linnaeus

GALÁPAGOS ISLANDS

These islands represent a Pacific outpost for cowries found in the coastal waters of Central and South America; thus collections from the Galápagos Islands should be given especial consideration to see what species are filtering into the islands. The continental Cypraeidae of the western Americas which have reached these islands

are: *Cypraea albuginosa* Gray, *Cypraea arabicula* Lamarck, *Cypraea cervinetta* Kiener, *Cypraea isabella mexicana* Stearns, *Cypraea nigropunctata* Gray, and *Pustularia pustulatata* (Lamarck). A number of writers have dealt with the molluscan fauna of these islands, among which are notably Dall and Ochsner (1928), Hertlein (1937), Hertlein and Strong (1939), Pillsbury and Vanatta (1902), Stearns (1893), Tomlin (1927), and Wimer (1880); only Ingram (in press) has considered the Cypraeidae as a unit. The only Polyneesian species to move into the Galápagos cowry fauna is *Cypraea moneta* Linnaeus. (Hertlein, 1937; Ingram, in press.)

Other outpost areas off the shores of the Americas where mollusks from the shore waters of Central and South America intermingle with those from Polynesia are Cocos Island, Clipperton Island, Tres Marias Island, and Revillagigedo Islands. (Hertlein, 1937).

VILLAMIL SETTLEMENT, SOUTHEAST ALBEMARLE

Cypraea cervinetta Kiener

The measured individuals are small compared with other specimens that the writer has examined from the Galápagos Islands. (Ingram, in press.) Five individuals vary in size from 72-45-27.60 to 59.70-29.30-22.50. The three intermediate individuals measure 68.50-33-25.40, 67-30-24, 65.80-31-24.80.

Cypraea nigropunctata Gray

Thirty-one individuals collected as beach shells vary in size from 35-20.20-16.60 to 20.50-11.50-9.50.

CHARLES ISLAND

Cypraea nigropunctata Gray

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